APPENDIX O.1

QUALIFICATIONS – KEY PERSONNEL

HUDBAY MINERALS

TUCSON OFFICE
Hudbay
Rosemont Copper Company
5255 East Williams Circle
Suite W1065
Tucson, Arizona 85711
CORPORATE WEB: www.hudbayminerals.com

Copper World Project

Technical Capabilities/Qualifications

- Javier Del Rio
- David Krizek
- Olivier Tavchandjian
- Javier Toro
- Clarissa Barraza
- Matthew Taylor
- Craig Hallworth

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JAVIER DEL RIO

VICE-PRESIDENT, SOUTH AMERICA AND THE USA

Professional Summary:

Mr. Del Rio is a multicultural mining executive with over 30 of experience in the mining industry in both corporate and business unit roles and in open-pit, underground, and expansion initiatives. As VP of South America and the USA for Hudbay Minerals Inc., he is responsible for the strategic and operational performance of the business units located in Peru, Arizona, and Nevada, which also includes executive oversight of human and capital resources for the business units and ensuring corporate standards are met in environmental management, health, and safety performance and community relations.

Mr. Del Rio, since joining Hudbay in 2010, has held management positions in Canada and Peru, in the areas of business development and business unit leadership. Prior to that, he held management positions in Newmont Mining Corporation in the USA and in Peru in the areas of business planning, optimization process, and business analysis; he began his career working underground as a mining engineer in the highlands of Peru.

Qualifications

- ***Education***:

  - Bachelor of Science in Mining Engineering. The National University of Engineering. Lima- Peru. 1984-1989.
  - Master of Business Administration. The University of Denver. 2002-2004
  - Institute of Corporate Directors, ICD.D, ICD-Rotman, Directors Education Program. The University of Toronto – Rotman School of Management. 2021.

- ***Registration/Certifications/ Licenses/Affiliations***:

  - Kuya Silver Corp. Member of the Board of Directors. 2022-Present
  - Peruvian Canadian Chamber of Commerce. Director. 2020-Present

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DAVID KRIZEK

ENVIRONMENTAL MANAGER

Professional Summary:

Mr. Krizek has over 26 years of experience with various mine site closure, improvement, and environmental compliance. His responsibilities have included: development and management of projects related to remedial cleanup actions; geotechnical and environmental investigations; permitting; facility process improvement/optimization; management of engineering design and construction activities for mine facilities and environmental compliance; technical review and management reporting, selecting and managing contractors, and directing internal support departments; project planning financial analysis, budgeting and expense tracking, scheduling, and overseeing equipment and material selection and procurement; analysis of underground openings and pit slopes using numerical modeling techniques such as limit equilibrium, finite difference, and boundary element methods; and surface and underground mine design studies.

Qualifications

- ***Education*:**
  - BS, Mining Engineering. Colorado School of Mines. 1987.
- ***Registration/Certifications/ Licenses/Affiliations*:**
  - Professional Civil Engineer:
    Arizona #31696. 1997.
    Nevada #14251. 2006.
    New Mexico #16003. 2003.
  - Member of Society of Mining, Metallurgy, and Exploration
  - MSHA Part 46 (Surface Metal / Non-Metal)
  - Hazardous Waste, RCRA, Method 9 Certification

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OLIVIER TAVHANDJIAN

VICE-PRESIDENT, EXPLORATION AND TECHNICAL SERVICES

Professional Summary:

Mr. Tavhandjian has been a key member of the senior management team since 2017, leading Hudbay's exploration strategy and adding significant value through growing the mineral resources and reserves at all Hudbay's key assets. His more than 30 years of experience in strategic and life of mine planning has provided invaluable support to the Hudbay's operations.

Mr. Tavhandjian holds a Ph.D in Mineral Resources from the University of Quebec in Chicoutimi and is a Professional Geoscientist registered with the Association of Professional Geoscientists of Ontario. Since joining Hudbay, Mr. Tavhandjian has redefined the resource modeling approach which has been highly successful in converting resources to reserves and extending the mine life at Constancia (Peru) and Snow Lake (USA). He has also worked closely with the Arizona team in defining and executing the exploration strategy at Copper World Project and leading the Mason, Nevada PEA. Most recently, he has been leading the PEA at the Copper World Complex Project.

Qualifications

- ***Education*:**
  - Ph.D. in Mineral Resources from the University of Quebec in Chicoutimi.
- ***Registration/Certifications/Licenses/Affiliations*:**
  - Professional Geoscientist. Association of Professional Geoscientists. Ontario - Canada.

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JAVIER TORO

EXECUTIVE DIRECTOR, MINING

Professional Summary:

Mr. Toro is a mine/geotechnical engineer with over 21 years of professional experience in commercial and mining industries; mine, civil, geological, geotechnical, and drill & blast engineering. Recent job positions have included managerial, leading engineering and project teams, while earlier experience focused on technical skill development in mining (planning, operations, and drill & blast), and civil & geotechnical engineering. Mr. Toro has a background in mining technical services seeking out and driving the execution of initiatives to continuously improve mine value via strategic plans with lower costs and higher production efficiency. Experience includes both as a consultant and miner.

Qualifications

- ***Education***:

  - Bachelor of Science in Mining Engineering. Engineering National University. Lima - Peru. 1990-1995.
  - Probabilities, Uncertainties and Reliability in Geotechnical Engineering. Milton Harr (professor emeritus Purdue University). Santiago de Chile- Chile. 2006.
  - Blast Design and Assessment for Surface Mines and Quarries. Edumine Courses, Infomine. Peru. 2008.
  - High Specialization Program (PAE) Mining Management. ESAN University. Lima - Peru. 2010.
  - Open Pit Mining. Design and Operation. Intercade. Lima - Peru. 2010

- ***Registration/Certifications/Licenses/Affiliations***:

  - Registered Professional Engineer. Peruvian College of Engineers. Credential ID 67998.
  - IIMP Professional Member. Peruvian Institute of Mining Engineering.

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CLARISSA BARRAZA

ENGINEERING DIRECTOR

Professional Summary:

Mrs. Barraza has been working in the mining industry for over 21 years with 14 years at Hudbay. Her responsibilities have included managing, directing, and coordinating the engineering, procurement, and construction efforts for Hudbay's business units. Her role in the Project includes; definition and maintenance of the EPCM scope; establishing priorities and work schedules for the engineering teams; ensuring that the procurement and contract action plans are technically supported; project planning coordinated with mining, procurement, engineering, and construction; EPCM engineering deliverables and the respective progress, part of the commissioning team and QA/QC; managing the QA/QC of the EPCM contractor; support on-site construction activities as required; review of technical evaluations, recommendations, and contracts; review constructability and operability plans; and respond to, manage, and maintain records for technical information from the EPCM and other outside entities.

Qualifications

- ***Education*:**
  - Bachelor of Science and Engineering with an emphasis in Mechanical Engineering. Arizona State University, 1998.

- ***Registration/Certifications/Licenses/Affiliations*:**
  - Engineer-In-Training (EIT) Certification.

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MATTHEW TAYLOR

EXECUTIVE DIRECTOR, METALLURGY TECHNICAL SERVICES

Professional Summary:

Mr. Taylor began working for Hudbay in 2019 as the Manager, Metallurgy, leading the company's brownfield project development in the processing areas for the company's existing assets in Peru and Canada. In addition to brownfield project development, he is involved at various levels in all Hudbay's business units providing process technical input. In May 2022 his role changed to Executive Director, Metallurgy Technical Services.

Mr. Taylor has worked for over 11 years in diverse roles in the mining industry including plant operations (Glencore), project development and implementation (Glencore/Newcrest/Hudbay), and laboratory testing (Newcrest/Hudbay/JKMRC).

Qualifications

- ***Education:***

  - Bachelor of Engineering in Mineral Processing Engineering. University of Queensland, Brisbane – Australia. 2004 – 2010.

- ***Registration/Certifications/Licenses/Affiliations*:**

  - Member of the Australasian Institute of Mining and Metallurgy. ID 223297
  - Awarded as "Mineral Processor of the Year". Recognition by Canadian Institute of Mining Awards Gala. 2022.

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CRAIG HALLWORTH

DIRECTOR, FINANCE – HUDBAY MINERALS

CFO, ROSEMONT COPPER COMPANY & MASON RESOURSES (US) INC.

Professional Summary:

Mr. Hallworth leads finance and other support teams for Hudbay's portfolio companies in Southwestern United States. His role includes advising Executives and the Board of Directors on corporate finance matters and supporting their decision-making. This includes accountability for Hudbay's internal financial models as well as the development and utilization of business intelligence, risk, management, and model auditing tools.

Qualifications

- ***Education*:**
  - Bachelor's Degree, Accounting (honours). Ryerson University. Toronto - Canada. 2002-2006.
  - Chartered Accountant / Chartered Professional Accountant, Accounting. CPA Canada. 2009.
  - CFA Charterholder, Finance, General. CFA Institute. 2017.

- ***Registration/Certifications/Licenses/Affiliations*:**
  - Chartered Accountant / Chartered Professional Accountant, Accounting. CPA Canada. 2009.
  - CFA Charterholder, Finance, General. CFA Institute. 2017.

APPENDIX O.2
RESUMES – KEY PERSONNEL

PITEAU ASSOCIATES

PITEAU ASSOCIATES
Geotechnical and Water Management Consultants
A TETRA TECH COMPANY

JEREMY DOWLING

PRESIDENT
CHIEF ADVISOR - HYDROGEOLOGY

EDUCATION

Master of Science (M.Sc.)
Hydrogeology,
University of East Anglia, 1994

Bachelor of Science (B.Sc), (Hons: first class)
Applied Environmental Geology,
University of Portsmouth, 1992

Morgan Jones Memorial Prize, Department of Geology, University of Portsmouth, 1992

QUALIFICATIONS AND EXPERIENCE

Jeremy Dowling was appointed President, October 2020. Jeremy succeeds Mark Hawley, who has held the position of President and CEO since 2009.

Jeremy joined Piteau Associates in 2016 as Vice President of Mine Water Management. He has more than 25 years of global experience in mining hydrogeology, surface and underground mine dewatering, pit slope depressurization, mine water management, integrated groundwater and engineering geology studies. Prior to joining Piteau Associates Jeremy was a member of the Strategic Management Team at Water Management Consultants and later with Schlumberger Water Services. Since joining Piteau Associates he has been instrumental in the growth and global expansion of the Piteau Group and the integration of our Geotechnical, Hydrogeology and Mine Water Management teams.

The following is a summary of Jeremy's extensive qualifications and experience.

- Lead Hydrogeologist for the Evaluation, Design and Implementation of Highland Boy Drainage Gallery, North Wall and South Wall Drainage Gallery Evaluation, Bingham Canyon.
- Peer reviewer for pit slope depressurization programs at numerous large open pit Copper mines.
- Patent Author new technical approaches for mine dewatering including integrated applications with well placement methods, directional drilling and high end pumping technology.
- Successful implementation of worldwide first Mine Dewatering Well Placement with Directional Drilling at two locations in North America, in 2013.
- Major contributing author to the industry sponsored LOP book on Guidelines for Open Pit Dewatering and Pit Slope Depressurization.
- Industry Expert in Surface and Underground Mine Dewatering and Pit Slope Depressurization.
- Consultant and Advisor to major open pit and underground mine development and expansion programs in North and South America, Asia and Europe.
- Technical Lead for pit slope drainage tunnel evaluation and implementation at multiple large open pit mines.
- Innovator of workflow to integrate open pit hydrogeology with geotechnical analysis for open pit slope design and optimization.
- Participant in Industry Technical Review Boards for Mine Development and Expansion.
- Contributing author to the Open Pit Slope Design Manual (LOP program).
- Actively involved in knowledge transfer and education to the mining industry in areas of mining hydrogeology, mine water management, mine dewatering, applied numerical modelling.
- Extensive experience in North America, South America and Europe.
- Bi-lingual (English and Spanish).

CAREER HISTORY

2020/present:	Piteau Associates USA Ltd. President, Chief Advisor Hydrogeology
2016/2020:	Piteau Associates USA Ltd. Vice President, Mine Water Management
2012/2016:	Mining & Water Global Practice Manager
2008/2012:	Water Management Consultants, Principal Hydrogeologist
2003/2008:	Water Management Consultants, Office Manager
2000/2003:	Water Management Consultants, Senior Hydrogeologist
1998/2000:	Water Management Consultants, Senior Hydrogeologist/Project Manager
1995/1997:	Water Management Consultants, Hydrogeologist
1994/1996:	Southern Science Ltd., Hydrogeologist

PROFESSIONAL AFFILIATIONS

- Member Society of Mining Engineers
- Member Northwest Mining Association
- Member Nevada Geological Society

PITEAU ASSOCIATES
Geotechnical and Water Management Consultants
A TETRA TECH COMPANY

BRIAN GIROUX, P.G., C.Hg., C.E.M.

SENIOR HYDROGEOLOGIST

EDUCATION

Master of Science (M.S.)
Hydrogeology
University of Nevada, Reno, 1998.

Bachelor of Science (B.S.)
Geological Sciences
San Diego State University, 1993.

QUALIFICATIONS AND EXPERIENCE

Brian Giroux is a Senior Hydrogeologist with 29 years of experience performing hydrogeological characterization, baseline/compliance monitoring, vadose zone hydrology, groundwater flow and solute transport modeling, contaminated soil and groundwater characterization and remediation, abandoned mine lands research and reconnaissance, water resource investigation, industrial water management, aquifer storage and recovery investigation, strategic water rights management, environmental permitting, and third-party review for project quality assurance.

Brian manages complex projects and multidisciplinary teams and strives to add value to projects by applying considerable experience in mine site hydrogeological characterization including geologic and hydrologic characterization, piezometer and standpipe design and installation, borehole geophysical surveying, test well design and installation, aquifer test design implementation and analysis, RIB investigation, seep and spring surveys, and conceptual, analytical and numerical groundwater modeling.

CAREER HISTORY

2018/Present:	Piteau Associates Senior Hydrogeologist
2001/2018:	McGinley & Associates, Inc. Senior Hydrogeologist
1999/2001:	SRK Consulting Project Hydrogeologist
1998/1999:	United States Antarctic Program Research Assistant
1997/1998:	Desert Research Institute Research Assistant
1992/1996:	United States Geological Survey Hydrologist

PROFESSIONAL CREDENTIALS

- Arizona Professional Geologist, #71971.
- California Certified Hydrogeologist, #784.
- California Professional Geologist, #7246.
- Nevada Certified Environmental Manager, #1742.

SELECT PROJECT EXPERIENCE

Bald Mountain Mine, Ely, NV - Pre-NEPA hydrogeological characterization of a mining pit expansion project. Leading an interdisciplinary team including geology, hydrology and geochemistry, to determine the impact of groundwater on the mine pit expansion project, and to incorporate a water demand study involving a planned heap leach pad expansion, and to incorporate updates to the existing waste rock management plan.

Relief Canyon Mine, Lovelock, NV - Baseline and characterization projects to support NEPA and state permitting for an update to the mine's Plan of Operations. Development of waste rock characterization, a predictive pit lake geochemistry model, and investigation and design of rapid infiltration basins (RIBs). In addition, third-party review of other baseline documents, including the project groundwater flow model, has been provided to insure defensibility and the shortest possible permitting timelines.

Marigold Mine, Valmy, NV - Development of an alternative discharge feasibility evaluation including recommendations for Environmental Impact Statement (EIS) alternatives.

Prospect Mountain Mine, Eureka, NV - Groundwater supply development, testing and analysis project. Delivering a robust water supply for the mine and supporting the environmental assessment for state and federal permitting, including strategic water rights management; the newly developed water supply system was successfully permitted with vested rights during the Diamond Valley adjudications.

PITEAU ASSOCIATES
Geotechnical and Water Management Consultants
A TETRA TECH COMPANY

DWAINE EDINGTON, PhD, PG, QP

SENIOR HYDROGEOLOGIST

EDUCATION

Doctor of Philosophy (PhD)
Geological Engineering
Colorado School of Mines, 2003.

Professional Degree (Prof.Deg.)
Geological Engineering
Colorado School of Mines, 1981.

Bachelor of Science (BS)
Geological Engineering
Colorado School of Mines, 1979.

QUALIFICATIONS AND EXPERIENCE

Dr. Edington has over 39 years of consulting and research experience in hydrogeology, modeling, stratigraphy, sedimentology, fluvial geomorphology, hydrology, hydrodynamics, and sediment transport. He specializes in the characterization, conceptualization, analysis, and numerical modeling of subsurface flow and contaminant fate and transport using analytical, finite-difference, and finite-element methods. He is experienced in site investigation, water balance modeling, engineering assessment, geophysical log analysis, computer-aided exploration, database management, risk analysis, and economics. He has served as a consultant to mining, petro-chemical, petroleum, litigation, and municipal clients.

Dr. Edington has worked on projects involving groundwater resources, groundwater contamination and remediation, petroleum exploration and development, risk and economic analysis, and systems operation and optimization. He has also participated in the preparation of Environmental Impact Statements. Dwaine's projects include sites in Alaska, Arizona, Arkansas, California, Colorado, Massachusetts, Mississippi, Nevada, New Mexico, New York, Ohio, Oregon, Texas, Utah, Wisconsin, and Wyoming and internationally in Australia, Slovakia, Mexico, Sweden, and Peru. He has experience in MODFLOW, FEFLOW, GoldSIM, MathCAD, QGIS, Microsoft Office and many other applications.

- Numerical modeling in support of open pit and underground mine dewatering and slope stability analysis.
- Fate and transport numerical modeling for USEPA Superfund sites.
- Fate and transport modeling in support of litigation.
- Numerical groundwater modeling in support of permitting for proposed mines in the US and internationally.
- Site-wide water balance modeling for numerous projects worldwide.
- Subsurface characterization and development of site conceptual models for projects worldwide.
- Numerical modeling and analysis in support of USEPA Environmental Impact Studies.
- Numerical modeling for municipal water supplies.

CAREER HISTORY

2019/present:	Piteau Associates Engineering Ltd. Senior Hydrogeologist
2016/2019:	WSP Lead Hydrogeologist
2011/2012:	Tetra Tech Senior Hydrogeologist
2005/2011:	Geomega Senior Hydrogeologist
2004:	Self Employed Senior Hydrogeologist
2000/2001:	Halepaska and Associates Staff Scientist
1993/2003:	Colorado School of Mines PhD Research Associate
1981/1992:	Texaco Senior Exploration Geologist

PROFESSIONAL AFFILIATIONS

- Registered Member, Society of Mining Engineers (No. 4186725)
- American Geophysical Union (AGU)
- Geological Society of America (GSA)
- National Groundwater Association (NGWA)

PITEAU ASSOCIATES
Geotechnical and Water Management Consultants
A TETRA TECH COMPANY

MARTIN WILLIAMS, BSc, PhD

COO – WATER MANAGEMENT
CHIEF ADVISOR – GEOCHEMISTRY

EDUCATION

PhD
University of Edinburgh, UK, 1987

Bachelor of Science, (BSc Hons Class 2:1)
University of Southampton, UK, 1983

LANGUAGES

English and Spanish, speak, read and write

QUALIFICATIONS AND EXPERIENCE

Martin Williams is COO – Water Management and Global Mining Geochemistry Advisor with Piteau Associates. He has 30 years of post-doctoral experience in mining geochemistry and related fields, gained in more than 40 countries across Europe, Africa, Australia, Asia and the Americas. Key areas of specialization include acid rock drainage (ARD) prediction, control and treatment; waste rock and tailings management; mine closure/rehabilitation and predictive geochemical modelling.

He provides advice on practical mine water management issues to the world's major mining corporations including Newmont, Barrick, Rio Tinto, Anglo American and AngloGold Ashanti. He is also retained as a Review Board member at a range of mining operations across all continents.

Martin is an internationally recognized expert in practical mine water management, with extensive experience of geochemistry aspects of mining projects from pre-feasibility level design and environmental permitting, through mine operations to closure. He is a consultant and technical reviewer for the world's principal gold and base metal producers. He is a long-term consultant to multilateral agencies (World Bank, IFC) and national regulatory authorities in the field of minerals sector environmental compliance. Martin has extensive experience of design and implementation of systems for treatment of acid water and mine process effluents, including HDS, membrane, ion exchange and related technologies.

He is the principal author or co-author of more than 100 publications within established international journals and mining industry magazines and has an extensive record of

peer review publications in the fields of environmental geochemistry and mining-environmental management.

CAREER HISTORY

2016-present:	Piteau Associates Vice President and Global Geochemistry Advisor
2008–2016:	Schlumberger Water Services Group Chief Geochemist and Global Mining Advisor
2006-2008:	Minerals Corporation, Ecuador Country Manager International
2001-2006:	WMC, Chile Principal Group Geochemist
2000-2001:	Komex International Ltd. Mining Sector Manager (Latin America)
1997-2000:	World Bank, Ecuador Mining Environmental Advisor
1990-1997:	BGS International Sector Manager, Mining Environment (Africa, SE Asia)
1988-1990:	University of Malawi, Africa Lecturer in Geochemistry and Hydrogeology,
1983-1984:	Project Geochemist, British Geological Survey, UK

PROFESSIONAL AFFILIATIONS

Registered Professional Geologist: SACNASP, South Africa.Acacia, Bulyanhulu Mine, Tanzania (ongoing)

PITEAU ASSOCIATES
Geotechnical and Water Management Consultants
A TETRA TECH COMPANY

TYLER CLUFF

SENIOR HYDROGEOLOGIST

EDUCATION

Master of Business Admin (M.B.A.)
Western Governors University, 2017.

Master of Science (M.S) Cum Laude
Hydrogeology
University of Nevada, Reno, 2007.

Bachelor of Science (B.S.) Cum Laude
Geology (minor in mathematics)
Weber State University, 2004.

QUALIFICATIONS AND EXPERIENCE

- Expertise in engineering mine dewatering and slope depressurization systems, numerical groundwater modeling, and geochemical modeling.
- Expert groundwater flow and transport modeling. Software expertise includes: Groundwater Vistas, MODFLOW, MT3DS, ARCGIS, PHREEQC, Fortran, Matlab, GoldSim, HYDRUS, SVFlux, TOUGH2, NUFT, Petrel, MULTIFLUX, SEEP-W.
- Water and geochemical mass balance systems modeling for pit lakes, mine sites, vadose zone, and groundwater systems using a dynamic systems models (GoldSim) and spreadsheet models.
- Qualified Person (QP) for lithium brine resource 43-101 evaluation.
- Geochemical characterization and evaluation of lakes, streams, leach pads, waste rock, and groundwater systems.
- Expert GIS skills for spatial data, database querying, and automated workflow scripting. Geospatial software experience includes AutoCAD, ArcView, ArcMap, ArcInfo, Spatial Analyst, 3D Analyst, Python, and Petrel.
- Field experience with wide spectrum of aquifer characterization tests and analysis including: constant - discharge pumping test, step-drawdown pumping test, slug test, packer testing, infiltration tests, and Guelph permeameter.
- Structural geology of the Basin and Range and Central Rockies including sites in the Salt River Range Wyoming, Eastern Nevada, Wasatch Front Utah, and Southwestern Wyoming.
- Developed a dynamic approach for evaporation and evapotranspiration modeling in arid environments.

CAREER HISTORY

2016/Present:	Piteau Associates USA Ltd. Senior Hydrogeologist
2016:	WSP | Parsons Brinckerhoff Lead Geologist/Project Manager
20011/2016:	Schlumberger Water Services Senior Hydrogeologist
2008/2011:	Water Management Consultants Project Hydrogeologist
2005/2007:	Dr. George Danko Graduate Research Assistant
2004/2005:	Utah Water Science Center USGS Physical Scientist Technician
2004 (Jul-Aug):	Dr. Adolph Yonkee Research Assistant
2003/2004:	Delta Aquifer, Ogden, UT Research Assistant

PROFESSIONAL AFFILIATIONS

- Professional Geologist (PG #8827) in the State of California.
- Engineer Intern (EI # 0T6646) in the State of Nevada.
- Nevada Water Resources Association
  Geological Society of Nevada
- MSHA safety training

APPENDIX O.3
RESUMES – KEY PERSONNEL

WOOD

Randy L. Huffsmith, P.E. BCEE
US Mining Sector Lead

Summary

Years of Experience

34

Office of Employment

Helena, Montana

Core skills

- Over 30 years consulting experience
- Project or Construction Manager for millions of tons of mine waste clean-up
- Over 100 mine-site and smelter CERCLA / reclamation project sites
- Managed design/construction at multiple +$50M projects
- Regulatory and permitting expertise
- Water treatment system construction and operations and civil design
- Steep slope reclamation
- Waste encapsulation and liner construction

Languages

- English

Professional Summary

Randy Huffsmith is Vice President, US Mining Sector Lead for Wood. Randy has consulted for mining companies for more than 30 years and has evaluated remedial alternatives at hundreds of inactive and abandoned mine sites and smelters including project and construction management for millions of tons of earth and waste movement, and oversight and management of hundreds of millions of dollars of construction. His career began in Wyoming, researching reclamation technologies for coal projects and modeling the behavior of steep slope reclamation projects where he obtained his master's degree in Engineering at the University of Wyoming. Randy worked for an ASARCO subsidiary in the 1980s and early 1990's completing civil and environmental engineering projects at mines and smelting facilities. He has worked in a consulting capacity on projects for many major mining companies, agencies, Mine Waste Site Trustees in Montana, Idaho and Arizona and other clients in the US, South and Central America. Randy has directed engineering teams supporting new projects and operations with values in excess of $1B and has led many multidisciplinary teams in all phases of mining from concept through closure. Randy is a subject matter expert in the reclamation of mining sites, waste encapsulation, surface water management and erosion and sedimentation and has supported the management, construction and civil engineering aspects of mine water treatment and mine water management at many mining sites. Example successful engineering and construction service relationships include clients such as Barrick, Newmont, Freeport-McMoRan, Asarco, BP, Doe Run, Teck, Rio Tinto, BHP, and numerous others.

Qualifications

Education

M.S. Engineering (Ag/Civil), University of Wyoming, 1988

B.S. Engineering (Ag/Civil), University of Wyoming, 1986

Registrations/Certifications/Licenses/Affiliations

Professional Engineer Montana, 1992, Arizona, 2015

Board Certified Environmental Engineer, American Academy of Environmental Engineers, 1999

Society of Mining, Metallurgy and Exploration

American Academy of Environmental Engineers

Experience

Mine Waste Clean Up and Reclamation

- **Project Director McCracken Mine Arizona Reclamation and Remediation. This Reclamation Project was awarded the BLM Large Hard Rock Mine Reclamation Project of the Year Award by BLM in 2017.** The project site was a historic Lead/Silver Mine and tailings, and waste rock were present in numerous ephemeral drainages and on steep slopes and adjacent to the underground mine portal. Our team designed a repository that encapsulated the mine impacted material over the historic working to reduce seepage into the waste and workings while maintaining critical desert ecology and protecting against future monsoon storm events.
- **Project Director or Senior Engineer for BP Mine sites.** Completed numerous engineering and environmental investigations and/or remedial engineering construction on confidential projects for BP. These projects include stabilization of steep slopes at former copper mines, removal of mine waste, pond and lined facility decommissioning, water treatment plant design, construction management and commissioning. Disturbed land reclamation has included all phases of voluntary actions and CERCLA required engineering and management. Facilities include pits, heap leach pads, tailings, and ancillary mine support operations. Mr. Huffsmith has lead teams in a safe fashion with a current teamwork record on our last project reaching over 100,000 hours without a lost time accident.
- **Project and Construction Manager, Doe Run CERCLA site.** Design of a mine waste remedial system, storm water drainage, stream design, hauling and placing clean-fill and capping materials, management of a large repository and engineering support. CERCLA site includes mine, mine dumps and historic flotation mill and tailings impoundment. Project has included tens of thousands of tons of waste removed and the site reclaimed with amended soil materials and thousands of trees and robust vegetation. Mine site stability was evaluated using the Vulcan 3D Model and high-definition LIDAR imagery. Unstable, near surface stopes were located and stabilized with backfill and other capping methods. Acid drainage was significantly reduced to adjacent Galena Creek by using acid resistant concrete plugs and other grouting techniques for seeps from drifts and stopes near the stream. A significant increase in stream pH has resulted from the actions and metals loading of the stream has also been significantly reduced.
- **Program Director and Project Manager, Teck American Inc., Mine Reclamation and Remediation Investigations, Colorado, Montana, Alaska, and Washington.** Reclamation and remediation at multiple mine sites as well as environmental investigations and expert support. Construction Management, capping mine waste piles, stabilizing mine features such as shafts and portals and underground workings, designing and constructing large mine waste repositories. Phosphate underground mine feature closures have included 3D Vulcan Modeling, volume estimates, evaluation of hydraulic conditions, closure with earth and concrete fill techniques. Closure and stabilization with Poly Urethane Foam (PUF) for openings, subsidence areas, stope and tunnel failures, and water management issues.
- **Project Manager, ASARCO, El Paso Smelter Remediation, Texas.** Completed the engineering and construction of the Diesel I groundwater remediation project in the early 1990's that successfully cleaned-up groundwater and received a no further action response from TCEQ. More than 10 years later, asked to oversee development of the final site clean-up remediation plan for the site which included oversight and review of numerous contractors including ENTACT, Arcadis and CDM. The project designs included a slurry wall, and groundwater recovery system, bench, and field scale testing

of water for treatment and design of a water treatment plant as well as smelter waste excavation, hauling and placing into a repository. Management responsibilities included the landfill closure work, the capping plan, and the surface water improvements. Arsenic and lead impacted soils, diesel fuel and other metals were part of the remedial program. The project had a $50M clean-up budget.

- **Engineering Manager, Reclamation of the Douglas Mine.** Design and construction oversight of large mine subsidence stabilization and reclamation project. Historic block cave stopes have been safely stabilized using earth and poly urethane stabilization techniques. Analysis has included rock mechanics, geotechnical stability analysis, mine modeling using Vulcan and other software, and re-establishing a native plant ecosystem as well as controlling noxious and invasive weed species.
- **Engineering Manager, Town of Basin Mine Waste Superfund Clean-up Basin, Montana.** Design and clean up waste residential and commercial area clean-up primarily for lead and arsenic impacted soils including hauling to a local repository. Engineering included waste characterization, removal plans, coordination of clean-up with residents and final cover and native crop establishment. Much of the work was conducted in hard-to-reach areas with steep slopes and significant environmental concerns such as streams and residences.
- **Project Manager, Reclamation, Basin Creek Mine.** Work at this site included multiple reclamation projects for heap leach pads, steep slopes, caps, pilot tests of water treatment technologies, revegetation, and slope stability analysis.
- **Design and Field Engineer Manager, Lead Smelter CERCLA Clean-up, East Helena, Montana.** Design and construction oversight of residential and commercial area lead smelter impacted soils including hauling to a local repository. Engineering included waste characterization, removal plans, coordination of clean-up with residents and final cover and native crop establishment. Hundreds of yards and gardens were remediated including schools, churches, and commercial properties. Utilities, trees and shrubs, foundations and clean documentation all required special consideration and controls.
- **Project Manager, Reclamation, Water Balance Cap Study – Montana Tunnels Mine.** At this site, we set up a pilot scale capping analysis plot using lysimeters to evaluate the types of soil water balance covers that would be effective in reducing water recharge to mine impacted materials and evaluated these systems for a 2 -year period.
- **Program Manager, Coeur D'Alene, Trust Mine Reclamation and Mine Waste Repository Design Engineering, Idaho, $500M Trust.** Design and construction oversight of large mine waste removal actions and repositories for this $500M trust including waste characterization, surface and groundwater contamination, geotechnical stability, repository design, effective cap design, revegetation and very large amounts of earth and waste movement. Sites include mines in and around the Silver Valley in Idaho, very steep slopes, limited access, high precipitation (snowfall), plan and specification development and bidder qualification as well as construction oversight.
- **Civil Engineer, Asarco Amarillo Historic Smelter Investigation.** Investigation and analysis of smelter impacts to soils and historic smelter waste from this Zinc smelter. Work included prefeasibility design, cost estimating for remedial measures, engineering analysis and investigation.
- **Senior Engineering Design, Luttrell Mine Waste Repository Design, US EPA, Basin, Montana.** Design and construction oversight senior engineering review of large mine waste repository for the Town of Basin Superfund site and the 10-Mile Creek Superfund Site. Repository utilized the open pit

from the Basin Creek Mine for the waste. Innovations such as a low perm wall and geosynthetics and a seepage collection system were included in this complex design. In addition, due to the steep nature of the highwalls, we developed a blasting plan to safely reduce highwall steepness and remove physical hazard potential of landslides and falling rock.

- **Engineering Manager, USFS Multi Site Mine Waste Removal Actions, Montana and Idaho.** Investigation and analysis and EECA's for multiple mine waste sites in Montana and Idaho. Projects included repository design and construction, waste characterization and volumetric estimates, surface, and groundwater sampling, contracting support, Construction oversight and management. Sites typically included removing or stabilizing mine impacted materials in high mountain environments with steep slopes, limited accessibility, and challenging weather conditions.
- **Engineering Design, Asarco Tacoma Smelter, Tacoma, Washington.** Design and construction oversight of multiple remedial measures for this historic lead smelter, earth moving, waste containment, storm water design and construction.
- **Mine Sector Manager, Design/Construction Management and CQA for Nevada Mining Projects**. Multi-million-dollar projects in Nevada including Newmont Long Canyon Heap Leach Pad Construction Quality Testing, Barrick Turquoise Ridge Water Treatment Plant Construction Management and Newmont Phoenix Leach Project Commissioning of the $200M new facility, multiple heap leach pad liner Construction Quality Assurance projects with tens of thousands of square feet of liner.
- **Engineering Manager, 10-Mile Creek Mine Waste Superfund Clean-up, Helena, Montana.** Investigation and analysis of more than 200 historic mine sites in the 10-Mile Creek Superfund area. Design and construction oversight for remedial measures, sampling and waste characterization, support planning and management aspects and budget.
- **Project Director, Black Butte Copper Project.** Responsible for our mobile laboratory and Construction Quality Assurance Team doing all the geotechnical and civil engineering testing for a new copper mine including pads and ponds and other surface facilities. Support preparation of a preliminary design for a mine water treatment system.
- **Program Director, ASARCO, Ray Mine, Arizona**. Tailings Removal, Storm water, Water Supply Piping. Storm water design, Construction Management and Oversight. Water delivery and Bellgravia Tailings Removal from multiple locations.
- **Program Director, ASARCO, Salero Ranch and January Adit Environmental Remediation Arizona.** Storm water design, water treatment analysis, reclamation, engineering design, APP submittal and compliance, construction, waste removal and repository construction for a large historic property. Slopes as steep as 1.5 to 1 were addressed and waste was removed, and the slopes were stabilized.
- **Flathead Basin Commission, Steep Road Cut Reclamation.** Randy was brought into this project as a subject matter expert to help the Commission reduce the sediment reaching a local high-quality stream. The road cut in question was steep and in some cases hundreds of feet high with little or no vegetation. Using multiple earth moving and capping techniques, we were able to reestablish vegetation and remove significant amounts of erosion from the cut and subsequent sedimentation to the stream.

- **Reclamation planning, waste encapsulation, water management and construction.** The above projects are just a few examples of Randy's mine reclamation and remediation experience. He can provide many more examples upon request.

Active Mining and Industrial

- Program Manager for multiple new mine development and reclamation planning projects in US and South America. Overall project values in excess of $1 billion.

Donald East
Technical Director

Summary

Years of Experience

50

Office of Employment

Lima, Peru

Areas of Expertise

- Highly specialized experience in the design, construction, and operation of heap leach facilities
- Expertise in thickened tailings storage facilities, including design and review of filtered tailings stacks.

Professional Summary

Don is Wood's Technical Director for Peru. He is responsible for the overall technical direction of the Environment & Infrastructure business line in Peru, which is dedicated to the provision of environmental, social, geotechnical and tailings consulting, engineering, and project management services to mining clients in South America. He is familiar with the CDA dam safety review procedures and has been the team leader for the annual dam safety inspections for the 158m-high Toromocho tailings dam in 2018, 2019 and 2020. In addition, he has led the risk reviews for Glencore's three operating tailing facilities and Pan American Silver's tailing facility in Bolivia. He is the Engineer-of-Record (EoR) for 5 large tailings facilities in Perú and Bolivia, including Southern Copper's Quebrada Honda 200,000tpd cyclone sand tailings facility and is the support EoR for Antofagasta Minerals tailing facilities at El Mauro and Centinela operations in Chile.

Don has also spent the last 30 years as designer and reviewer of heap leach pads in North and South America. He managed the design of Newmont's heap leach pads in Nevada and was responsible for the design and construction QA for the very large Yanacocha gold leach in Perú starting at project inception in 1993 through to 2004.

Don also provides senior-level reviews of technical work performed by the Lima office.

Qualifications

Education

MS, Geotechnical Engineering, University of Birmingham, UK

BS, Civil Engineering, University of Cape Town, RSA

Publications / Presentations

- Author or co-author of more than 30 professional and technical papers on tailings and heap leach facilities

Languages

- English
- Spanish

Experience

Graña y Montero 2013 - 2017

Director of Mining Division

Responsible for technical oversight and business development for the Engineering Division, GMI. The company has more than 2,500 personnel who provide engineering, procurement and construction services to mining, power, infrastructure, industrial and other clients, from initial design through to operations. He was the geotechnical lead for the design and construction (EPC) of Guyana Goldfields' 5,000 tpd gold project in Guyana.

Gran Colombia Gold 2011 - 2012

Chief Operating Officer

Responsible for four operating underground mines and two process plants in Colombia producing 110,000 oz/year of gold and 1Moz/ year of silver. Planned and developed a new underground mechanized mine and 2,500 tpd process plant in Segovia, Colombia to boost production to 200,000 oz/yr. Directed the scoping and prefeasibility studies for the 14Moz Marmato gold-silver mine and its initial development for comingling tailings with waste rock.

Anglo American, 2009-2010

Project Development Manager, Michiquillay Project, Peru

Managed conceptual engineering of a large copper concentrator project, overseeing exploration, the scoping study, and baseline, water and environmental data collection and analysis.

Rio Tinto, 2006-2009

Project Director, La Granja project, Peru: Rio Tinto Minera Perú

Management of the prefeasibility study of a 300,000 to 500,000tpa copper leach project, including heap leach pad and leach system design, mining studies, and infrastructure (road upgrade, exploration tunnel, power, water, port).

Gold Fields, 2004-2005

Project Director, Cerro Corona, Peru

Managed the feasibility study of a 6.2M tpy copper-gold mine and mill, including planning, process engineering and procurement, mining, thickened tailings facility, infrastructure and permitting support.

Knight Piésold and Co, 1975-2004

- **President and CEO, Knight Piésold International, 1999-2004**. Responsible for the international expansion of an established global consulting business. Engineer of Record for design of thickened tailing storage facilities in Nevada for Newmont, Barrick Goldstrike and Anglo Gold. Independent reviewer of the design of a 300m high coal waste tailings facility for Massey Energy in West Virginia. Restructured the company's international professional practice.
- **President and CEO, Knight Piésold USA, 1985-1999**. Developed the design principals for heap leach pad design and construction for Newmont's operations in Nevada and successfully adapted these to South America's largest heap leach facility at Yanacocha in northern Perú. This project built

up to include 4 mines with associated heap leach facilities. He was also responsible for the design of thickened tailings storage facilities for many large mining projects in Africa and the USA.

- **Rio Blanco, Monterrico Metals, 2005-2006.** Responsible for prefeasibility design of mine waste and tailings storage options for a large copper concentrator in northern Perú.
- **Southern Peru Copper, Peru, 2005.** Managed a new concept for a thickened tailings study to expand the capacity of the Quebrada Honda cycloned tailings facility which serves the Cuajone and Toquepala copper concentrators.
- **Yanacocha, Newmont, Peru, 2003-2004.** Project Manager of the 800M-tonne La Quinua gold heap leach pad and mine waste storage project at a large gold mining complex, responsible for all aspects of the design, construction, and operation.
- **Partner, WLPU Consulting Engineers, Johannesburg, 1979-1984.** Managing a wide range of industrial and mining projects and associated work including civil, mechanical, electrical, architectural, military, ports, roads, rock mechanics and geotechnical engineering.
- **Geotechnical Manager, WLPU Johannesburg, 1975-1978.** Assigned to major geotechnical projects including the 2,000 MW Koeberg nuclear power facility, the 3,600 MW Matla and Duvha thermal power plants, and Pretoria Portland Cement's Dwaalboom and Jupiter cement plants, as well as Anglo American's 90,000tpd ERGO gold tailings retreatment project and associated 800Mt cyclone sand tailings dam.

Civilab, 1972-1974

Manager of a commercial engineering testing laboratory in Johannesburg, building it up into a viable, profitable company. The laboratory was jointly owned by Ove Arup and Partners and WLPU Consultants.

Ninham Shand and Partners, 1969-1972

Geotechnical engineer and manager of a geotechnical and materials testing laboratory. Responsible for design, materials location and testing, and construction of roads and other geotechnical projects. Field engineer for an expansion of part of the regional road network.

Richard Weber, CEM
Associate Project Manager - Environmental

Summary

Years of Experience

31 (8 with Wood)

Office of Employment

West US & LATAM - Denver

Professional Associations

- Member, National Association of Environmental Professionals
- Member, Society for Mining, Metallurgy and Exploration

Areas of Expertise

- Environmental Scientist - Expert
- Project Manager – Expert

Professional Summary

Mr. Weber has over 30 years of diverse experience focusing on environmental permitting and compliance, closure, and reclamation planning, NEPA compliance, baseline surveys, environmental audits, site investigations, remediation, and wildlife mitigation. His focus has been primarily in the mining and power industries and has permitted a variety of projects with federal, state, and local regulatory agencies. He has prepared and managed the development of numerous NEPA compliant documents including Categorical Exclusions and Environmental Assessments. He also has experience as the Deputy PM on a large mine expansion EIS. He has conducted this work for a variety of federal agencies including the BLM, USFS, USACE, DOE, and NGB. In addition to his NEPA and EIA experience, he has worked with clients and regulatory agencies to obtain a variety of permits for water use, water discharge, underground injection control, stormwater discharge, air emissions, mining and reclamation, dredge and fill of wetlands, road construction, and local special use permits. He has conducted and managed numerous Phase I and Phase II ESAs, assisted in the design and implementation of remediation systems, conducted compliance monitoring for mining and other industrial companies, and conducted environmental audits. Mr. Weber has conducted wildlife investigations resulting in development of wildlife mitigation strategies to reduce impacts.

Qualifications

Education

Master of Science, Biology, Northeastern University, 1990

Bachelor of Science, Biology, University of South Dakota, 1986

Registrations / Certifications / Licenses

Certified Environmental Manager, EM-1727

Additional Training

- MSHA 24 Hour
- OSHA 40 Hour HAZWOPER
- FAA Wildlife Hazard Assessment Training
- Wetland Delineation Training

Experience

Project Manager

Standard Mine, TPPC and WPCP Renewal, Florida Canyon Mining Inc., NV

Mr. Weber was the project manager responsible for preparing the renewal application for FCMI's Standard Mine Water Pollution Control Permit (WPCP). In addition to the WPCP renewal package, Wood also assisted FCMI in updating the Tentative Plan for Permanent Closure (TPPC). The work included face-to-face meetings with the NDEP BMRR staff regarding expectations for the permit documents. Wood worked closely with FCMI's environmental staff to prepare the WPCP renewal application and TPPC. The package was submitted to NDEP for review and comment. Wood assisted FCMI's staff in addressing comments from the agency.

Environmental Lead

Rain Mine Final Plan for Permanent Closure Addendum, Nevada Gold Mines, NV

Wood was retained by Nevada Gold Mines to design an engineered cover for a portion of the Rain Mine North Waste Rock Disposal Facility and revise the existing Final Permanent Plan for Closure (FPPC). Mr. Weber was the lead in developing the addendum to the FPPC, which addressed the new cover design for a portion of the waste rock disposal facility. Mr. Weber reviewed the existing FPPC and determined through discussions with NGM that the best approach was to develop an addendum rather than revise he currently approved plan. Once the design was completed, Mr. Weber led the environmental group in preparing the addendum to the FPPC. The addendum provided a summary of the previous work conducted at the NWDF since the facility was construction, and summary of the proposed cover design for an approximately 75-acre area of the NWDF. The FPPC addendum package was submitted to NDEP for approval.

Project Manager

Haile Gold Mine Reclamation Plan and EIS, Haile Gold Mine Inc., Kershaw, SC

Project manager and project scientist to update the reclamation plan and reclamation cost estimate based on design changes and changes in unit rates from the original cost estimate. This included providing a description of the reclamation methods for each of the mine facilities, determining volumes of material, identifying the unit rates, and preparing the reclamation report. Several methods were used to calculate the reclamation cost estimate including a spreadsheet prepared by the original author of the reclamation plan and using the Nevada Standardized Reclamation Cost Estimator (SRCE). Numerous iterations were prepared as a result of meetings with the agencies and changes in the design during the EIS process. In addition, I supported the client with the EIS through critical reviews and edits to the reclamation section and project description. Currently working on an update to the reclamation plan and reclamation cost estimate based on a proposed expansion of the mine.

Project Manager / Lead Auditor

Northern Nevada Mine Site Legal Compliance Audit (Site Confidential), Newmont Mining Company, NV

Project Manager and lead auditor for environmental compliance audits at a large northern Nevada mine. Mr. Weber led a team of three auditors focusing on NEPA compliance, stormwater and water management, waste management, and air compliance. A team conducted the audit through review of records, site inspections and interviews. A report was prepared for Newmont's outside counsel.

Lead Environmental Scientist

Environmental Permitting, Clients – Barrick, Hycroft, General Moly, NV

Prepare dam safety permits for three Nevada mines (Bald Mountain, Mt. Hope, and Hycroft). This included preparing the permit application forms, compiling the necessary design documents including geotechnical reports, design reports, drawings, and technical specifications. Also prepared the Artificial Industrial Pond permit application and assisted in the preparation of the Water Pollution Control permit application for the Mooney Basin heap leach expansion project.

Assistant Project Manager

Bald Mountain Mine, North Operations Area Project EIS, Barrick Gold Corporation, Elko, NV

Mr. Weber was the Assistant Project Manager for a third-party EIS for the Ely District Bureau of Land Management for the expansion of the Bald Mountain Mine located approximately 60 miles south of Elko, Nevada. The project included the expansion of several existing open pits, a new heap leach pad, and construction and or expansion of a variety of ancillary facilities. Mr. Weber's responsibilities for the development of the EIS included attending all internal and external project meetings, providing input to the resource specialists, writing specific sections of the EIS, reviewing the EIS for technical adequacy, and addressing comments on the Draft EIS. Significant issues included air quality (mercury), wildlife (mule deer migration), water quality, and threatened and endangered species. Mr. Weber conducted much of the communication with both the BLM specialists, and the proponent project manager, and assisted the Project Manager with budget and schedule control. From the initial start of the project, the PDEIS was completed in approximately 4.5 months.

Project Manager / Project Scientist

Haile Gold Mine Reclamation Plan and EIS Support, Haile Gold Mine Inc, Kershaw, SC

Project manager and project scientist to update the reclamation plan and reclamation cost estimate (RCE) based on design changes and changes in unit rates from the original cost estimate. This included providing a description of the reclamation methods for each of the mine facilities, determining volumes of material, identifying the unit rates, and preparing the reclamation report. Several methods were used to calculate the reclamation cost estimate including a spreadsheet prepared by the original author of the reclamation plan and using the Nevada Standardized Reclamation Cost Estimator (SRCE). Numerous iterations were prepared as a result of meetings with the agencies and changes in the design during the EIS process. In addition, Mr. Weber supported the client with the EIS through critical reviews and edits to the reclamation section and project description. The Reclamation Plan and RCE were updated in 2018-2019 to address a planned expansion of the mine.

Project Manager / Project Scientist

Mule Canyon EA, Newmont Mining Company, Battle Mountain, NV

Mr. Weber was the project manager and lead scientist in the development of a spring mitigation EA as part of the Mule Canyon Mine. Spring mitigation was required under the mitigation section of the EIS for the mine. Once a mitigation site was selected, the EA was required to address potential impacts associated with improving the spring to prevent cattle access to the spring but allow water for livestock through installation of a spring box and piping to a trough. Significant issues included water quality and quantity, and grazing, which included providing better water availability to livestock.

Project Manager

South Railroad Exploration Project, Gold Standard Ventures Corporation, NV

Mr. Weber was the project manager for baseline surveys, preparation an EA, and permitting for an exploration project containing over 8,000-acres and located south of Carlin, NV. Surveys included documenting noxious weeds, vegetation communities, rare plants, general wildlife, bat habitat, breeding and migratory birds and nests, and raptors. Wood biologists also conducted aerial and terrestrial raptor surveys, and ambient noise monitoring at numerous sage grouse lek locations. Wood prepared a NEPA-compliant EA, which did not receive any public comments during the public comment period. Staff closely coordinated with the client, project designers, and the BLM Tuscarora Field Office to ensure all requirements were met and the project moved forward in a timely manner.

Marc E. Orman, P.E., G.E.
Principal Geotechnical Engineer

Marc.orman@woodplc.com
(720) 966-8690

Summary

Years of Experience

39 years

Industries

- Mining

Types of Facilities

- Tailings Storage Facilities
- Pit Slope Stability and Design
- Heap Leach
- Waste Dumps
- Foundations
- Retaining Structures
- Slope Stabilization
- Borrow Sources

Areas of Expertise

- Conceptual Studies
- Pre-Feasibility Studies
- Feasibility Studies
- Detailed Design
- Front End Engineering
- Borrow Source Evaluations
- Field Testing and Sampling
- Laboratory Testing

Professional Summary

Mr. Orman has over 35 years of geotechnical and civil engineering experience as related to mine development, expansions, operations and closure. Mr. Orman specializes in geotechnical studies related to heap leaching, open pit slope stability, tailings storage facilities, and design optimization, waste dumps and soil and rock fill slopes. Mr. Orman's technical expertise includes assessment of rock and soil material properties, field investigative methods, laboratory test methods, seepage and slope stability analyses and design. Mr. Orman has worked on numerous mining projects in wet and highly seismic areas. Mr. Orman has a keen understanding of field investigative geotechnical methods, monitoring, in-situ field and laboratory testing of rock, soil, tailings, and geosynthetic materials. Mr. Orman has worked on mining projects located in North America, Central America, South America, Kazakhstan, Siberia, Bulgaria, Indonesia and West Africa. Mr. Orman fulfills the requirements to be a "Qualified Person" for the purposes of NI 43-101 reporting.

Qualifications

Education

MS, Civil Geotechnical Engineering, University of Arizona, 1989

BS, Civil Engineering, University of Arizona, 1986

BS, Geophysics, Northern Arizona University, 1981

Registrations / Certifications / Licenses

Professional Engineer in Nevada, Alaska Arizona, California, Idaho and Washington, USA

Professional Geotechnical Engineer in California, USA

Mine Safety & Health Administration (MSHA) – Instructor

Marc E. Orman, P.E., G.E.
Principal Geotechnical Engineer

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Publications / Presentations

- Orman, M.E. and Servigna, D. A., "What is a Credible Tailings Dam Failure", 2021 Tailings and Mine Waste 2021 Conference, Alberta, Canada.
- Orman, M.E., Small, C.A., and Al-Mamun, M., 2017., "Tailings Dam Classification and Breach Analyses, the Perspective of the Canadian Dam Association", Presentation for the 25th Annual Mine Design, Operation & Closure Conference, Fairmont, Montana.
- Preciado, H.F., Orman, M., Byler, B., and Fleming, S., 2016, "Challenges and Benefits from Placing Filtered Tailings Over a Former slurry Storage Facility", Tailings and Mine Waste '16, Keystone, Colorado.
- Orman, M.E., Romo, D., and Tremanye, R., 2013. "A Case Study of the Ocampo Phase 1 Heap Leach Expansion", Heap Leach 2013, Organized by InfoMine, Vancouver, Canada.
- Orman, M.E., Peevers, R., and Sample, K., 2011, "Part 8: Ground Mechanics, Section 8.11 Waste Piles and Dumps", lead author, SME Mining Engineering Handbook, Third edition, volume one, edited by Peter Darling, Society for Mining, Metallurgy, and Exploration, Inc., Denver, Colorado.
- Orman, M.E., 1999, "The Future of Geosynthetic Heap Leach Systems", Geosynthetic Research Institute, GRI-13, Annual Conference Proceedings, Philadelphia, Pennsylvania.
- Orman, M.E. and Criley, K., 1997, "Ore Permeability Testing For Heap Leach Design", Society for Mining, Metallurgy, and Exploration, 1997 Annual Convention, Reprint No. 9749, Littleton, CO.
- Ramey, T.V., Orman, M.E., and Smith, M.E., 1996, "Designing Leach Pad Liners for Differential Settlement", Randol Gold Forum '96, Olympic Valley, CA.
- Smith, M.E., and Orman, M.E., 1996, "Design Considerations for Closure Caps for Waste Piles and Tailings", Randol Gold Forum '96, Olympic Valley, CA
- Orman, M.E., and Criley, K., 1996, "Staged Permeability Testing for Optimizing Heap Leach Heights", Randol Gold Forum '96, Olympic Valley, CA.
- Queja, C.B., Orman, M.E., and Hlinko, M.J., "Flexible Membrane Liner Compatibility Involving Copper Leaching Solution", Society for Mining, Metallurgy, and Exploration, 1995 Annual Convention, Reprint No. 95-116, Littleton, CO.
- Smith, M.E., Orman, M.E., and Queja, C.B., "Copper Heap Leaching - A Case for PVC Liners", Geomembrane Technical Bulletin, March 1995. This paper won 1st place for technical content from the PVC Geomembrane Institute (PGI).
- Orman, M.E., "Interface Shear Strength Properties of Roughened HDPE", ASCE, Journal of Geotechnical Engineering, April, 1994.
- Orman, M.E. and Nowatzki E.A., "Prediction of Bedding Intrusion into Low Strength Subgrades", ASCE, Journal of Geotechnical Engineering, February 1993, (Master's Thesis).
- Post, J.L. and Orman, M.E., "Genesis and Physical Properties of Beidellite and Illite-Beidellite from Near Silver City, Idaho", Clay Minerals Society, Journal, 1992.
- Orman, M.E., 1991, Contributing Author, Mine Waste Management, California Mining Association, Hutchinson & Ellison, Ed., 1991
- Orman, M.E. and Smith, M.E., Chapter 1, "Mining Performance Review", California Mining Association (CMA) White Paper, CMA, Sacramento, CA 1990.
- Dohms, P.H., M.E. Smith and M.E. Orman, "Mining Waste Management in California, Issues and Concerns", Proceedings of GOLDTech 4, SME, Reno, NV. Sept. 1990.
- Orman, M.E., M.E. Smith and P.H. Dohms, "Mining in California: How Are We Doing Under Subchapter 15?" Proceedings of the Western Regional Symposium on Mining and Mineral Processing Wastes, U.C. Berkeley, CA., May, 1990.

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Principal Geotechnical Engineer

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Software / Skills

- WORD, EXCEL, RocScience Geomechanical Software.

Languages

- English

Experience

Tailings Project Experience

Principal Geotechnical Engineer

Capstone, Pinto Valley Tailings Storage Facility No.5

Pre-Feasibility Design of TSF#5 at the Pinto Valley Mine, Arizona

Project director and lead geotechnical engineer for a new tailings storage facility. The planned facility will store over 300 million tonnes of tailings. Scope of work included field investigation, mapping, laboratory testing, geotechnical engineering and design at the pre-feasibility level.

Principal Geotechnical Engineer

Teck, Closure Design for Tailings Storage Facility No. 3

Closure design, Washington

Principal geotechnical engineer for the closure to landform status for this conventional tailing storage facility. Project tasks included site visit, geotechnical field investigation, laboratory testing, alternatives review, selection and design preferred alternative.

Principal Geotechnical Engineer

BHPB, Lisbon Valley Uranium Tailings Storage Facility

Dam Safety Report, Utah

Project manager for the DSR and geotechnical safety audit of this closed historic facility. Project tasks included site visit, documentation review, dam classification and risk assessment. Provided recommendations to help lower the risk of the facility.

Principal Geotechnical Engineer

BHPB, Ambrosia Tailings Storage Facility

Dam Safety Report, New Mexico

This reclaimed tailing storage facility is the largest in North America and contains over 33 million tons. Project manager for the DSR and geotechnical safety audit of this closed historic facility. Project tasks included site visit, documentation review, dam classification and risk assessment. Provided recommendations to help lower the risk of the facility.

Principal Geotechnical Engineer

Penoles, Saucito Tailings Storage Facilities

Dam Safety Inspection, Zacatecas, Mexico

A dam safety inspection was performed for the four cells of the polymetallic mine operation. The DSI included meetings with Mine representatives to discuss the TSF operations, instrumentation and monitoring program, ongoing construction activities, and findings from on-site observations. The project used starter embankments with upstream raise construction methods.

Principal Geotechnical Engineer

Penoles, Fresnillo Tailings Storage Facilities

Dam Safety Inspection, Fresnillo, Mexico

A dam safety inspection was performed for eight separate tailings storage facilities of the historic and currently operating polymetallic mine operations directly adjacent to the town of Fresnillo. The DSI included meetings with mine representatives to discuss the TSF operations, instrumentation and monitoring program, ongoing construction activities, and findings from on-site observations. The project used starter embankments with upstream raise construction methods using cyclone sands. Construction data was limited for some of the facilities due to their age.

Principal Geotechnical Engineer

Penoles, Tizapa Tailings Storage Facilities

Dam Safety Inspection, Mexico, Mexico

A dam safety inspection was performed for the three separate tailings storage facilities of the polymetallic mine operation. The DSI included meetings with Mine representatives to discuss the TSF operations, instrumentation and monitoring program, ongoing construction activities, and findings from on-site observations. The project used embankment dam construction methods. Facility two had one 5m raise constructed as part of its completion.

Principal Geotechnical Engineer

IamGold, Camp Caiman Filtered Tailings Waste Rock Co-Disposal Facility

Pre-Feasibility Design, French Guiana, South America

Principal Geotechnical Engineer for pre-feasibility level design co-disposal of filtered tailings and waste rock in the open pit in a tropical environment. The operation has strip ratio of 1:1 and will be sized for 1 Million tonnes per year over a 9-year life of mine.

Principal Geotechnical Engineer

Minera Rio Tinto, Cieneguita Mine

Conceptual Design of Filtered Tailings and Waste Rock Co-Disposal Facility, Cieneguita, Mexico

Principal Geotechnical Engineer for the Preliminary design of 60 million tonne co-disposal facility located in northern Mexico. Tasks included citing and sizing the facility, storm water routing, and geotechnical planning.

Principal Geotechnical Engineer and EOR

Rio Tinto, U.S. Borax

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Boric Acid Tailings Storage Pond 7, Boron, California

Engineer of Record for the Boric Acid tailings and R-Ponds. The ring dike containment structures which are composed of compacted engineered fill. The operation has fifteen tailings facilities. The impoundments are lined with either clay or a double liner using high density polyethylene with a system to detect and collect leakage. Tasks involved included characterizing embankment and foundation materials and tailings, seepage and stability analyses.

Principal Geotechnical Engineer

Endeavour Silver, Mina Guanacevi

Filtered Tailing Storage Facility, Guanacevi, Mexico

Principal geotechnical engineer for the expansion of their tailings storage facilities. The project involves the stacking of filtered tailings over a conventional wet tailings facility. The scope of work included characterization of the site, wet and filtered tailings, laboratory testing, and analyses. Acceptable levels of stability have been achieved using a combination of buttress construction (using filtered tailings), extraction wells, and controlled loading.

Principal Geotechnical Engineer

Southern Peru Copper Company, Los Chancas

Los Chancas Filtered Tailings Storage Facility, Abancay, Peru

Principal geotechnical engineer for the design of the co-disposal dry stack tailings storage facility which had a capacity of 2.7 Billion tonnes with an ultimate height of 400 meters. The site is in a very steep seismically active high-altitude part of the Andes. The filtered tailings would be mixed with waste rock to aid in stability, drainage, and dust control.

Principal Geotechnical Engineer

Hudbay, Rosemont Copper Mine

Filtered Tailings Storage Facility, Tucson, Arizona

Principal geotechnical reviewer for the final design for the 75,000 tpd filtered tailings storage facility. The scope of work has included site and materials characterization, laboratory testing, analyses, and design. The TSF site will cover an area of several square miles and will be constructed using both advance and retreat methods in 25-meter-high lifts.

Senior Geotechnical Engineer

St. Augustine Gold and Copper Lmtd., King King Mine

Feasibility Design Filtered Tailings Storage Facility, Southern Philippines

Lead Geotechnical site engineer and reviewer for the pre-feasibility design of the filtered tailings disposal area and other process facilities. The site is in a very wet and seismically active area. Water management will be a key element of the operation of this facility.

Principal Geotechnical Engineer

Avino Silver & Gold Mines, Mina Avino

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Detailed Design for a new Tailings Storage Facility, Durango, Mexico

Principal geotechnical engineer and designer for the phase 3 tailings storage facility. The facility stores conventional slurried tailings and will use cyclones tailings to construct staged upstream raises over a lined impoundment with a waste rock buttress. Scope of work included a field investigation, laboratory testing and tailings characterization, seepage and stability analyses and construction level design.

Senior Geotechnical Engineer

Minera y Metalurgica del Boleo, Mina Boleo

Detailed Design and Construction Services El Boleo Tailings Storage Facility, Baja Sur, Mexico

Principal Geotechnical Engineer for the design optimization and construction of the 89 million tonne capacity valley fill tailings storage facility. The facility is unlined and consists of a series of downstream phased raises using rockfill and a three-stage filter zone. Tasks included a geotechnical field investigation, field and laboratory testing, seepage, filter design, and stability analyses.

Senior Geotechnical Engineer

Pan American Silver Corp, La Preciosa

Feasibility Level TSF design, Durango, Mexico

Geotechnical Engineering Study for Tailings Storage Facility, Process Plant site, and Tailings Pipeline. Project tasks included developing geotechnical field investigation program, managing field and laboratory testing, tailings storage facility sizing study, and report preparation.

Senior Geotechnical Engineer

PT Bumi Resources, Dairi Prima Mineral Project

Tailings Disposal Site Evaluation, Sumatra, Indonesia

Project manager and senior geotechnical engineer. The project involved a liquefaction susceptibility study of the Younger Toba Tuff. The scope involved field and laboratory testing to determine if this material needed to be removed and replaced from the area of tailings storage facility. The liquefaction risks and triggering events were estimated as part of this scope of work.

Principal Geotechnical Engineer

Hecla Mining Company, Lucky Friday Mine

Tailings Storage Facility Stability Evaluation, Northern Idaho

Principal Geotechnical Engineer for a slide assessment of a lined conventional tailings facility. Pore pressures developed below the liner within the subgrade due to springs. Remedial design options were provided as part of the scope of work.

Principal Geotechnical Engineer

Capstone Resources, Pinto Valley Mine

Design Review Tailings Storage Facility Expansion, Arizona

Principal Geotechnical reviewer for the expansion of Tailings dam number 4 which is a cycloned sand upstream raised embankment. Scope of work included a field investigation, laboratory testing, data review, material property determination, analyses, and design.

Senior Geotechnical Engineer

Endeavour Silver, El Cubo Mine

Tailings Storage Facility Expansion at Manstrantos IV, V, VI, and VII, Guanajuato, Mexico

Principal Geotechnical engineer and senior reviewer for the expansions to their ultimate build out of the upstream raised cycloned sand embankment. Scope of work included field investigations, laboratory testing, analyses and design. Final recommendations required the placement of a rock buttress to stabilize the embankment during the design earthquake event.

Senior Geotechnical Engineer

Endeavour Silver, Bolanitos

Tailings Storage Facility, Guanajuato, Mexico

Principal Geotechnical engineer for the life of mine expansion of the slurried tailings facility. Scope of work included field investigations, laboratory testing and analyses. Final recommendations required the placement of a rock buttress to stabilize the upstream cycloned sand embankment during the design earthquake event.

Principal Geotechnical Engineer

New Gold Inc., New Afton Mine

Phase 1 Tailings Storage Facility Detailed Design, British Columbia, Canada

Principal geotechnical engineer and designer for the proposed tailings storage facility. The scope of work involved a field investigation, laboratory testing, analyses, and design for permitting, construction, and closure. Special considerations included liquefaction susceptibility of glacial deposits underlying the site and the proximity of underground block caving operations.

Senior Geotechnical Engineer

Rayrock Mining Inc., Mina Bellavista

Conceptual Design Tailings Storage Facility and Waste Dumps, Miramar, Costa Rica

Geotechnical engineer for the tailings dam and waste dump designs. Tasks included a site investigation and sampling, laboratory testing program and engineering analyses including seepage and slope stability for a lined impoundment. Weak clay altered ash deposits made created stability issue for the waste dump located in steep terrain near the proposed open pit and underground workings.

Senior Geotechnical Engineer

Goldcorp, Marigold Mine

Detailed Closure Design Tailings Storage Facility, Humboldt County, Nevada

Geotechnical engineer for the closure of the conventional slurried tailings storage facility. Scope of work included tailings characterization and cover design.

Marc E. Orman, P.E., G.E.
Principal Geotechnical Engineer

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(720) 966-8690

Senior Geotechnical Engineer

Rayrock Mining, Inc., Pinson Mine

Detailed Design of Tailings Storage Facility Expansion, Nevada

Geotechnical engineer for the phase 2 and 3 expansion of the slurried tailings storage device. Provided geotechnical engineering and design services. Expansion used the downstream raise method with filter ring dikes.

Representative Heap Leach Projects

Project Director

Freeport McMoRan, Morenci,

Producer Stockpile, Morenci Mine, Arizona

Project Director and lead geotechnical engineer for the proposed valley fill leach stockpile. The proposed leach stockpile will have a capacity of approximately 900 million tons and an ultimate height great than 1,000 feet. Scope included design of 170 foot high jurisdictional dam and involved directing all geotechnical aspects of prefeasibility design from the field investigation, laboratory testing, materials characterization, seepage and stability analyses, drawings, and reporting.

Principal Geotechnical Engineer

Kinross, Tasiast

Tasiast Sud Leach pad, Mauritania, Africa

Pre-feasibility study of the conventional Leach pad design at Tasiast Sud. Directing all geotechnical aspects of prefeasibility design from the field investigation, laboratory testing, materials characterization, analyses, stacking plan, and drawings.

Principal Geotechnical Engineer

Aura Minerals, San Andres

Phase V and VI Leach Pads, Honduras

Leach pad designs for this high rainfall, steep, and seismically active site. Was involved in all aspects of Phase V from the field investigation, laboratory testing, materials characterization, analyses, design, stacking plan and access roads. Was the principal reviewer for phase VI but also highly involved in the stability analyses and stacking plan development. Is very familiar with the project from site development to the current conditions.

Principal Geotechnical Engineer

Southern Peru Copper Corporation, Los Chancas

Valley Fill Leach Pad and Co-Mingled Waste Disposal, Apurimac region, Peru

Los Chancas is one of the largest copper reserve in Peru and in the world having estimated reserves of 726 million tonnes of ore grading 0.47% copper, 0.04% molybdenum and 0.9 million oz of gold. The project is expected to produce approximately 179 million tonnes (Mt) of leach ore, 561 Mt of tailings at a throughput of approximately 80,000 tpd, 1,355 Mt of waste rock. AMEC completed a pre-

feasibility study including a design of both a co-mingled filtered tailings/waste rock Waste Storage Facility (WSF) and a Heap Leach Facility (HLF) to be contained in a single valley.

Principal Geotechnical Engineer

Minera Tayahua S.A. DE C.V., Calcosita Copper Project

Leach Pad, Zacatecas, Mexico

Feasibility to Detailed Design for a 15 Million tonne side hill copper leach pad. A unique design on a 12 percent slope with stabilizing toe berm. Tasks included field investigation, laboratory testing, hydrologic and hydrogeologic, analyses, and construction level design.

Senior Geotechnical Engineer

Minefinders, Dolores Gold Mine

Valley Fill Leach Pads, Chihuahua, Mexico

Detailed design of Phase I – III valley leach pads with external solution storage pond. While the design had an external solution storage pond, the facility was designed to withstand a complete pipe failure where solution would pond up within the heap to the crest of the embankment. The scope of services included the field investigations through construction support. Challenges included subgrade slopes in excess of 45 forty five degrees and a very remote location.

Principal Geotechnical Engineer

Aurico Gold Inc., Ocampo Mine

Phase 1 - III Leach Facilities, Ocampo, Mexico

Responsible for the field investigation through design and construction support during the Phase I expansion and design of the Phase III valley leach pad with internal solution storage ponds. The expansion of the Phase 1 gold/silver leach pad was completed in 2010 and effectively changed the Phase 1 flat pad with external pregnant leach solution (PLS) pond to a valley fill leach pad with an internal sump to remove the PLS. The conversion provided an additional ore storage capacity of approximately 10 million tonnes and extended the leach pad life.

Senior Geotechnical / Construction Engineer

Pegasus Gold, Basin Creek Mine

Phase 1 Leach Pad, Basin, Montana

Construction engineering and management of the Phase I valley leach pad with in heap solution storage ponds at this cold climate site located at approximately 10,000 foot elevation near Basin Creek, Montana. The liner system consisted of a double geomembrane lined pond area and composite Geosynthetic/clay liner in areas above the solution storage level. The design utilized steel riser and vertical turbine pumps to remove the PLS.

Senior Geotechnical Engineer

Coeur Mining, Rochester Mine

Phases I through IV Leach Pad, Rochester, Nevada

Design and construction engineering of the valley leach pad with in heap solution storage. Liner system composed of a composite system using compacted natural low permeability soils overlain by an 80-mil geomembrane. Embankment was designed and constructed using compacted native soils and included a toe drain and emergency spillway. Solution was removed from the heap using telescoping steel vertical riser pipes and vertical turbine pumps. Slope Stability was evaluated under static and seismic conditions considering the liner both intact and breached. Scope of work included the initial field investigation through construction.

Senior Geotechnical Engineer

Cripple Creek and Victor Mine Company, CC&V Mine

Cresson, and Victor Leach Pads, Cripple Creek Colorado

Scope work included the design review and construction support for the valley leach pads with internal solution storage pond. The design utilized riser pipes and vertical turbine pumps to remove solution from the ponded area. The maximum ore depth at the riser pipes was 125 meters. Geosynthetic liners were used both above and below the solution storage level.

Senior Geotechnical Engineer

Barrick Gold Corporation, Pierina Mine

Valley Fill Leach Pad, Huaraz, Peru

Phase I leach pad design and construction engineering for the largest and highest altitude valley leach pads in the world at that time. Solution was removed from the heap using telescoping steel vertical riser pipes and vertical turbine pumps. The liner system consisted of a double Geosynthetic liner in solution pond areas and composite system consisting of a Geosynthetic over compacted native low permeability soils. The embankment system was constructed using a clay core with internal drains. The monitoring system included a seismometer, piezometers, inclinometers, and displacement monuments. Scope of services included the initial field investigation through construction.

Senior Geotechnical Engineer

Meridian Gold Co., Beartrack Mine

Conventional Leach Pad, Salmon, Idaho.

Senior Geotechnical engineer and project manager for the leach pad detailed design and construction for this high altitude, cold climate project. The heap was designed as a conventional flat pad with external ponds.

Senior Geotechnical Engineer

NERCO DeLamar, DeLamar Silver Mine

Leach Pad, Silver City Idaho

Geotechnical Engineer involved in the forensic investigation of the heap leach pad slide. The site is located at high altitude in the Owyhee Mountains of southern Idaho which is a cold climate. The investigation showed that the leach pad slid due a thin very weak clay altered ash deposit located several meters below the bottom of the leach pad liner.

Senior Geotechnical Engineer

Marc.orman@woodplc.com
(720) 966-8690

American Resources Corp., Goldfields Mine

Leach Pad Design, Goldfields, Nevada

Project manager, senior geotechnical engineer and lead designer for the conventional flat leach pad with external storage ponds in this historic mining district of Nevada.

Senior Geotechnical Engineer

Bema Gold, Refugio Mine

Leach Pad Design, Chile

Project manager, senior geotechnical engineer and lead designer for the conventional flat leach pad with external storage ponds. The project is at high altitude in the Chilean Andes Mountains.

Senior Geotechnical Engineer

Compania Minera Dayton, Andacolla Gold Mine

Conventional Flat Leach Pad, La Serena, Chile

Project manager, senior geotechnical engineer and lead designer for the conventional flat leach pad with external storage ponds.

Senior Geotechnical Engineer

Pegasus Gold, Florida Canyon Mine

Circular Leach Pad Expansion Design, Imlay, Nevada

Senior geotechnical engineer, designer and project manager for the final 4 phases of the circular leach pad and ponds. The project involved field investigations, laboratory testing and analyses. Scope of services included construction support and closure. Also performed a geotechnical evaluation of the recently constructed south leach pad.

Senior Geotechnical Engineer

Codelco, Radomiro Tomic Mine

On/Off Leach Pad Design, Calama, Chile

Senior geotechnical engineer and designer of on/off leach pad. Provided borrow source investigation for subgrade and overliner materials, performed stability analyses, and oversaw CQC and CQA during construction.

Senior Geotechnical Engineer

Codelco, El Abra Copper Mine

On/Off Leach Pad Design, Calama, Chile

Geotechnical lead and leach pad design for the on/off pad. Provided borrow source investigation for the overliner materials, ore characterization, stability analyses, design and construction support. Tasks included liner design optimization and performance review.

Senior Geotechnical Engineer

Arizona Copper Corp, Sanchez Copper Mine

Conventional Flat Leach Pad, Safford, Arizona

Project Manager and senior geotechnical engineer and designer for the 100 meter high conventional copper heap leach. Scope of services included field investigation, laboratory testing, analyses, design, closure design, and permitting for the leach pad and storm water management.

Senior Geotechnical Engineer

Marigold Mining Corp., Marigold Mine

Run-of-mine Leach Pad, Valmy, Nevada

Senior Geotechnical engineer for several phases of the run-of-mine leach pad expansions. Scope of work included liner optimization, materials characterization, laboratory testing, analyses and design.

Senior Geotechnical Engineer

Barrick Gold, Ruby Hill Mine

Phase 1 leach Pad, Eureka, Nevada

Project Manager and senior geotechnical engineer for the phase 1 construction quality control and quality assurance for a conventional flat heap leach. Scope of services included construction services and project management.

Open Pit Slope Stability and Design Projects

Senior Geotechnical Engineer

Ioneer, Rhyolite Ridge Lithium Project

Pre-Feasibility Phase 1 and Ultimate Quarry Design, Tonopah, Nevada

Principal project Engineer for the prefeasibility level design for the Phase 1 starter and ultimate pits. Included investigations of the pit stratigraphy, mapping, oriented coring, data processing, analyses and recommendations for the slope design. Lithologies are composed of soft rock sediments which have been folded and faulted.

Principal Geotechnical Engineer

Compania Minera Zafranal, Zafranal

Zafranal and Victoria Copper Porphyry Feasibility Level Pit Design, Arequipa, Peru

Director and technical lead for the evaluation of new and historical information including field mapping, core drilling, laboratory testing and modelling and then perform geotechnical analyses to provide design recommendations for the new pit development at the proposed Zafranal porphyry copper mine. The proposed development includes the two open pits, the major one referred to as Zafranal and a smaller one to the east called Victoria.

Principal Geotechnical Engineer

Vale, Sorowako Mine

Pit Slope Stability Safety Review, Sulawesi, Indonesia

Marc was selected following an extensive global search and testing campaign by a major mining company to review the slope design process for a project that had been operating for several

decades. The scope included an audit of the field mapping, drilling, sampling, testing, analyses, monitoring and reporting procedures and provided recommendations to improve methods so that safer slopes could be achieved for the project.

Principal Geotechnical Engineer

ASARCO, Mina Maria

Mina Maria Open Pit Design, Sonora, Mexico

Principal Geotechnical Engineer for the recommended design of the pit slope angles for a large copper porphyry deposit in northern Mexico. Tasks included field mapping and data review as part of planning the program to optimize the final slope design for several sectors of the open pit. Provided preliminary slope design parameters for bench face angles, bench widths, inter-ramp and overall slope angles for the pit.

Senior Geotechnical Engineer

Iamgold, Cote Mine

Cote Gold Project, Ontario, Canada

Qualified Person (QP) for the Prefeasibility study of the open pit. Tasks included data, analyses, and design review of the slope design for all sectors of the proposed open pit.

Principal Geotechnical Engineer

IamGold, Camp Caiman Mine

Pre-Feasibility Pit Slope Design , French Guiana, South America

Qualified Person (QP) for the Prefeasibility study of the open pit. Tasks included data, analyses, and design review of the open pit slopes design for the proposed open pit. The project is complicated by high rainfall in an environmentally sensitive area.

Principal Geotechnical Engineer

St. Augustine Gold and Copper Lmtd., King King Mine

Pre-Feasibility Pit Slope Design, Davao, Philippines

Senior reviewer for the Prefeasibility study of the revised open pit design. Tasks included data, analyses, and design review of the open pit slopes design for the proposed revised open pit. The project is complicated by high rainfall, high seismicity region and social instability.

Principal Geotechnical Engineer

Silver Crest Mines, Inc., Mina Santa Elena

Open Pit Final Design, Sonora, Mexico

Principal Geotechnical Engineer for the recommended design of the final pit slopes. Tasks included field investigation and mapping, monitoring data processing and analyses required to optimize the final slope design for several sectors of the open pit. Analyses performed included factor of safety and risk of the critical wedge.

Principal Geotechnical Engineer

Minera Rio Tinto, Mina Cienguita

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(720) 966-8690

Cieneguita Open Pit Final Design, Chihuahua, Mexico

Principal Geotechnical Engineer a review of the field mapping, core drilling, sampling, laboratory testing and design of the final pit slopes. Tasks included field investigation of ongoing slope failures, planning and instructing mine personnel on mapping, logging, monitoring data processing and analyses required to optimize the final slope design for the final open pit slopes.

Senior Geotechnical Engineer

Mine Finders, Mina Dolores

Dolores High Wall Stability Assessment, Chihuahua, Mexico

Geotechnical engineer involved in the design of the final high-wall slopes. Reviewed laboratory, field mapping, and hydrologic data and utilized it to perform probabilistic kinematic slope stability analyses to determine the optimized bench face and inter-ramp slope angles.

Principal Geotechnical Engineer

Rio Tinto, U.S. Borax

Pit Slope Stability for In-Pit Waste Dump, Boron, California

Principal Geotechnical Engineer for slope stability assessment and design of the Central In-Pit Waste dumps. Included investigations of the pit stratigraphy. Lithologies are composed mainly of soft sediments. Also has provided open and waste dump inspections on an annual basis since 2007 in compliance with Rio Tinto policies and procedures for safety and geotechnical assessment of pit and waste dump slopes.

Principal Geotechnical Engineer

Assarel Medet JSC, Asserel Medet Copper Mine

Assarel Porphry Copper Pit Expansion, Bulgaria

Director and Principal Geotechnical Engineer for the phased expansion of the open pit that has been in operation since the early 1980s. Lithologies range from completely altered argillitic andesite to hard unaltered diorite. Tasks include angled oriented coring, logging, data acquisition, sampling, supervising and training client personnel, geomechanical laboratory testing, piezometer installation, ground water studies, analyses, and pit slope optimization.

Principal Geotechnical Engineer

Intergeo MMC Ltd., Ak-Sug Copper Mine

Pre-Feasibility Pit Slope Design, South Central Siberia

Senior Geotechnical Engineer for the open pit slope design optimization. Responsibilities included field exploration, coring, logging, laboratory testing, analyses and slope stability recommendations for the phased development of the open pit. Analyses performed included factor of safety and risk.

Principal Geotechnical Engineer

Cluff Gold Ltd., Baomahun Gold Mine

Feasibility Pit Slope Design, Sierra Leone, West Africa

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Principal Geotechnical Engineer for a large open pit with underground access feasibility level slope stability design. Tasks included oriented core drilling, sampling, laboratory testing, slope stability analyses and slope angle recommendations. Analyses performed included factor of safety and risk.

Senior Geotechnical Engineer

Pan American Silver, Alamo Dorado Mine

Detailed Pit Slope Expansion Design, Sonora, Mexico

Senior Geotechnical Engineer for the Optimization of the Expanded Phase 3 pit. Tasks included field investigation with several oriented core holes, sampling, laboratory testing and analyses required to optimize the slope design for several sectors of the open pit. Analyses performed included factor of safety and risk.

Senior Geotechnical Engineer

Barrick Gold, Bald Mountain Mine

Saga Open Pit Slope Design, White Pine County, Nevada

Principal Geotechnical Engineer for the expansion of the Saga pit. Scope of work included oriented core drilling and sampling, laboratory testing and analyses as required to optimize the slope angles. Stability analyses performed included factor of safety and risk.

Principal Geotechnical Engineer

Rare Element Resources, Bear Lodge Mine

Feasibility Pit Slope Design, Sundance, Wyoming

Principal Geotechnical Engineer for the feasibility open pit stability assessment of the open pits. Project scope included oriented core drilling, sampling, laboratory testing, analyses and design. Analyses performed included factor of safety, probability of slope failure and reliability.

Senior Geotechnical Engineer

Union Oil Company of California, Mountain Pass Mine

Open Pit Detailed Slope Design, San Bernardino County, California

Senior Geotechnical Engineer for the open pit stability assessment design of the open. Project scope included data review, mapping, surface sampling, laboratory testing, analyses and design. Analyses performed included factor of safety and risk analyses of the operating and final pit slopes. Prepared a reclamation plan for the final open pit.

Senior Geotechnical Engineer

Mine Arnaud Inc., Arnaud Mine

Feasibility Pit Slope Design, Quebec, Canada

Principal Geotechnical Engineer for the feasibility level open pit slope stability assessment. Tasks included field investigation planning and implementation, oriented core drilling and sampling, laboratory testing, slope stability analyses and pit slope recommendations based on slope optimization. Analyses performed included factor of safety and level of risk.

Senior Geotechnical Engineer

ArcelorMittal, Concentrator Iron Ore Open Pits

Feasibility Pit Slope Design for Yekepa, Tokadeh, Gangra, Yuelliton Open Pits, Liberia, West Africa

Technical Lead for the feasibility level pit designs of lateritic iron ore project. Slope stability evaluation included surface mapping, oriented core drilling, probabilistic analyses, and pit slope design recommendations. Analyses performed included factor of safety and associated risk.

Senior Geotechnical Engineer

American Vanadium, Gibellini Project

Feasibility Level Open Pit Design, Eureka, Nevada

Project manager and senior geotechnical engineer for the feasibility slope stability evaluation and design of the proposed pit. Analyses performed included factor of safety and risk.

Senior Geotechnical Engineer

Florida Canyon Mining, Inc., Florida Canyon Mine

Feasibility Level Pit Design, Imlay, Nevada

Senior Geotechnical Engineer and Project Manager for the pit designs of the Headwaters, Jasperoid Hill, and Sake pits. The project involved field mapping, laboratory testing and analyses using probabilistic slope stability methods of both kinematic and overall slope failure mechanisms to provide optimum design slope angles.

Senior Geotechnical Engineer

Freeport – McMoRan, Lone Star Copper Mine

Feasibility Level Open Pit Slope Design, Safford, Arizona

Geotechnical Engineer for the data acquisition of a large open pit copper porphyry project in southern Arizona. Tasks involved included oriented core logging and sampling as part of the final pit infill program for the project.

Senior Geotechnical Engineer

Lehigh Southwest Cement Company, Gray Rocks Quarry

Detailed Quarry Slope Design, Shasta County, California

Limestone quarry project. Senior Geotechnical Engineer and Project Manager for the quarry slopes, access tunnel, and waste dumps for low grade fines storage materials. Projects involved field mapping, core logging, laboratory testing, slope stability and seepage analyses, design of storm water control measures, subdrain system, and sediment capture ponds.

Senior Geotechnical Engineer

Lehigh Southwest Cement Company, Gray Rocks South Quarry

Feasibility Level Quarry Slope Design, Shasta County, California

Limestone quarry project. Senior Geotechnical Engineer and Project Manager for the quarry slopes, and waste dumps for low grade material storage. Project involved field mapping, core logging, laboratory testing, slope stability analyses, and design of quarry slopes and waste dumps.

Senior Geotechnical Engineer

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DeSilva Gates Construction, Barton Ranch Quarry

Feasibility Level Quarry Slope Design, Sacramento County, California

Hardrock aggregate quarry. Project manager and senior geotechnical engineer for the exploration, resource qualification and quantification, slope stability, hydrogeology, and quarry design in support of permitting. Tasks included field mapping, oriented core drilling, monitoring well installation, laboratory testing, modeling, analyses and design.

Principal Geotechnical Engineer

Granite Construction Company, Walltown Quarry

Feasibility Level Quarry Slope Design, Sacramento County, California

Hardrock aggregate quarry. Senior geotechnical engineer for the exploration, resource quantification and qualification, slope stability and quarry design in support of permitting. Tasks included field mapping, oriented core drilling, laboratory testing, modeling, analyses and design of quarry slopes.

Senior Geotechnical Engineer

Hanson Permanente, Permanente Limestone Quarry

Detailed Slope Design, Santa Clara County, California

Lead Geotechnical Engineer for the pit expansion and scenic easement ridge stability. Tasks included field mapping, drilling and logging, sampling, geomechanical laboratory testing, modeling and analyses as required to optimize the pit slope angles. The scope also included installation of monitoring devices and monitoring plan development and implementation.

Principal Geotechnical Engineer

Granite Construction Company, Keithly Ranch/ 175 Aggregate Quarry

Detailed Slope Design for Quarry Expansion, Lake County, California

Principal Geotechnical Engineer for the development of a large open pit aggregate quarry in northern California. Tasks included field mapping, geotechnical and hydrogeologic drilling, logging, samples, management of laboratory testing program, data analyses and pit slope angle design.

Principal Geotechnical Engineer

Granite Construction Company, Fountain Springs Aggregate Quarry

Detailed Slope Design for Quarry Expansion, Tulare County, California

Principal Geotechnical Engineer for the expansion of a hard rock aggregate quarry in central California. Tasks included geotechnical drilling, logging, sampling, management of laboratory testing program, data analyses and slope design.

Senior Geotechnical Engineer

Lehigh Southwest Cement Company, Tehachapi Limestone Quarry

Detailed Quarry Slope Design, Kern County, California

Limestone quarry project. Senior Geotechnical Engineer and Project Manager for the quarry slopes, and waste dumps for low grade material storage. Project involved field mapping, core logging, laboratory testing, slope stability analyses, and design of quarry slopes and waste dumps.

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Principal Geotechnical Engineer

Granite Construction Company, Buellton Sand and Gravel

Detailed Design for Quarry Expansion, Santa Barbara County, California

Senior project manager and geotechnical engineer for quarry slope design. Project tasks included seismic hazard evaluation, field investigation, sampling laboratory testing, slope stability analyses under static and earthquake conditions, final quarry slope recommendations and closure requirements.

Principal Geotechnical Engineer

CEMEX, Pleasanton Sand and Gravel Quarry

Slope Displacement Evaluation, Alameda County, California

Senior Geotechnical Engineer for the slope displacement evaluation. Scope of work included instrumentation installation, materials testing evaluation, data review and slope stability. Slope displacements were occurring along folded lakebed clay deposits at slopes as shallow as three to seven degrees.

Principal Geotechnical Engineer

Lehigh Southwest Cement Company, Gray Rocks Shale Quarry

Detailed Slope Design for Shale Quarry, Shasta County, California

Senior Geotechnical Engineer for the shale quarry slope design. Scope of work included field investigation, laboratory testing, material property evaluation, data analyses and slope design.

Principal Geotechnical Engineer

Lehigh Southwest Cement Company, Burney Quarry

Detailed Slope Design for Diatomaceous Earth Quarry, Shasta County, California

Principal Geotechnical Engineer for the slope evaluation and facility closure. Scope of work included a field investigation, data review and closure design. Site had a small pit lake and forty degree overall slope angles.

Waste Dump Facility Projects

Senior Geotechnical Engineer

Intergeo MMC Ltd., Ak-Sug Copper Mine

Pre-Feasibility Waste Dump Design, South Central Siberia

2013. Senior Geotechnical Engineer for the design of the western and Eastern waste dumps. Responsibilities included field exploration, coring, logging, laboratory testing, analyses and slope stability recommendations for the phased development of the dumps. The design included storm water diversions for environmental protection.

Marc E. Orman, P.E., G.E.
Principal Geotechnical Engineer

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Principal Geotechnical Engineer

Rio Tinto, U.S. Borax

Detailed Design for Ex-Pit and In-Pit Waste Dumps, Boron, California

Principal Geotechnical Engineer for slope stability assessment and design of the Central In-Pit and ex-pit Waste dumps. Scope of work included field investigations of dump material and foundation properties, slope stability analyses, and environmental controls design. Also provides annual inspection for in-pit and expit waste dumps and piles in compliance with Rio Tinto policies and procedures for safety and geotechnical assessment of pit and waste dump slopes.

Senior Geotechnical Engineer

Florida Canyon Mining, Inc., Florida Canyon Mine

Detailed Waste Dump Design, Imlay, Nevada

Senior Geotechnical Engineer and Project Manager for the waste dump designs. The project involved field mapping, laboratory testing and analyses of slope stability, storm water control, and reclamation design.

Principal Geotechnical Engineer

Lehigh Southwest Cement Company, Gray Rocks Quarry

Detailed Waste Dump Design, Northern California

Senior Geotechnical Engineer and Project Manager for a very large valley fill waste dump in a wet climate. The project involved field mapping, drill hole logging, laboratory testing and analyses of slope stability, storm water and natural spring water control. The facility was designed with an internal rock drain which carried both the spring and storm water runoff since diversion cannel construction was prohibitive due to the steep terrain.

Senior Geotechnical Engineer

St. Augustine Gold and Copper Lmtd., King King Mine

Pre-Feasibility Level Waste Dump Design, Southern Philippines

Lead Geotechnical Engineer for the pre-feasibility assessment of the foundation conditions for the waste dump facilities. Project involved field investigation planning, drillings, test pits and sampling. Also included laboratory testing, data analyses and recommendations.

Senior Geotechnical Engineer

NERCO – DeLamar, DeLamar Silver Mine

Waste Dump Stabilization Study, Southwest Idaho

Lead Geotechnical Engineer for waste dump stabilization project. Tasks included field mapping, monitoring, geomechanical laboratory testing, modeling, and analyses as required to assess and stabilize the waste dumps.

Principal Geotechnical Engineer

Hanson Permanente, Permanente Limestone Quarry

Waste Dump Displacement Study, Coastal California

Lead Geotechnical Engineer for the assessment of the waste dump displacement project. Tasks included field mapping, drilling and logging, sampling, geomechanical laboratory testing, modeling and analyses as required to determine the failure mechanism and provide remediation repair. The scope also included installation of monitoring devices and monitoring plan development and implementation.

Principal Geotechnical Engineer

Lehigh Southwest Cement Company, Tehachapi Limestone Quarry

Waste Dump Stability Assessment and Expansion Design, Tehachapi, California

Geotechnical Engineer for the waste dump slope stability assessment and design. Tasks included data acquisition and processing to assess the stability of the waste dump and storm water diversions required for environmental protection.

Senior Geotechnical Engineer

Southern Peru Copper Company, Los Chancas Porphry Copper Project

Comingled Waste Rock and Tailings Disposal Feasibility Design, Tapairihua District of Apurimac, Peru

Senior Geotechnical Engineer for the design of the comingled waste rock and tailings valley fill storage facility. The facility was designed to contained over 2.7 Billion tonnes of waste rock and tailings. The project included field investigations, geophysics, laboratory testing, geochemistry, analyses and design. Storm water control would through a system of rock drains and diversion channels. Environmental protection was a major concern with potentially acid generating waste rock storage required.

Principal Geotechnical Engineer

Lehigh Southwest Cement Company, Gray Rocks Quarry

Detailed Design Gray Rocks South Waste Dump, Northern California

Senior Geotechnical Engineer and Project Manager for the side hill waste dump. The project involved field mapping, drill hole logging and simple collection, laboratory testing and analyses of slope stability, storm water and natural spring water control. The facility was designed with an internal rock drain and storm water diversion channels.

Senior Geotechnical Engineer

Atlanta Gold, Inc., Atlanta Gold Mine

Feasibility Level Waste Dump Design, Atlanta, Idaho

Senior Geotechnical engineer for the waste dump and leach pad design. Project located in high altitude environmentally sensitive area surrounded water critical water sources. Project was complicated by terrain in excess of 40 degrees in facility areas, high snow fall, and acid generating waste rock.

Professional History

- Wood, Principal Geotechnical Engineer, Denver, CO (2009 – Present)

Marc E. Orman, P.E., G.E.
Principal Geotechnical Engineer

Marc.orman@woodplc.com
(720) 966-8690

- Sierra Geotechnical, Principal Geotechnical Engineer, Grass Valley, CA (2000- 2009)
- Vector Engineering Inc., Senior Geotechnical Engineer, Grass Valley, CA (1989 – 2000)
- C.E. Martin Engineers, Inc., Civil Engineer, Tucson, AZ (1987 - 1989)
- Stearns & Wheeler Engineers and Scientists, Civil Engineer, Cazenovia, NY (1986 - 1987)
- Shuffler Engineering and Roylance Engineering Firms, Civil Engineer Tech, Boise ID (1983 – 1984)
- Westland Mineral Exploration Company, Inc., Project Geologist, Tucson, AZ (1982 – 1983)
- Analex Corp, Wellsite Geologist, Denver, CO (1981 – 1982)

Todd Minard
Senior Tailings Engineer/Associate

Summary

Years of Experience
28

Office of Employment
Reno, Nevada

Education
- Bachelor of Science, Civil Engineering, California State University, Chico.

Registrations / Certifications / Licenses
- Registered Civil Engineer - Nevada No. 13199
- Registered Civil Engineer - California No. C57795

Professional Summary

Mr. Minard is a registered civil engineer with 25+ years of experience specializing in leading large multi-disciplined design projects supporting the mining industry, primarily with tailings storage facilities (TSF), heap leach facilities (HLF), ponds and haul roads. He manages all aspects of project development, from siting, preliminary economic assessments, pre-feasibility, feasibility, detailed design, permitting, construction, operations, and reclamation. Mr. Minard has performed all aspects of civil design; layout, water balances, hydrology, hydraulics, geomembrane liner, pressure and gravity pipeline design. He has global experience designing mine waste facilities and leach pads in Nevada, Australia, Africa, Turkey, China, Panama, Mexico, Peru, and the Dominican Republic.

Experience

Project Manager
Heap Leach and Processing Containment Facilities, Kirazlı Project, Alamos Gold Inc., Turkey

Mr. Minard was the Project Manager of the multi discipline project, and Lead Design Engineer for the design of a 750,000 square meter (m2) geomembrane lined leach pad that is designed to process 28.2 million tonnes of ore. The Kirazlı Project is a green field gold and silver mining development located in the Biga Peninsula in the province of Çanakkale, in north-western Turkey. To facilitate the permitting and design many technical studies were conducted including; an extensive deterministic seismic hazard analysis, probabilistic water balance, climate studies, Surface water hydrology and hydraulic, geochemistry (ore and waste), and geotechnical. The Kirazlı leach pad was designed in two phases; with the second phase constructed on top of a waster rock dump (the waste rock dump was developed during the operations of Phase 1).

Project Manager and Design Engineer
Ruby Hill Mine – Cell L Heap Leach Facility Expansion, Barrick Gold, NV

Project Manager and Design Engineer for the design and construction of a 512,00-square-foot expansion of the heap leach facility to process 3.1 million tons of gold baring ore stacked to 200 feet. Due to material sourcing restraints the solution collection liner systems included a geosynthetic clay liner (GCL) below the HDPE geomembrane liner. Prepared design drawings, technical specifications and supporting design documents.

Project Director
Cerro de Gallo, Argonaut Gold, Guanajuato, Mexico

Project Director for the Feasibility Design of a heap leach facility (HLF) that has an approximately 92 million tonnes ore capacity. The leach pad was designed to meet or exceed North American standards, such as the Nevada Administration Code 445A.434 for the lining system design and Mexican Standard NOM-155-SEMERNAT-2007 for stability of the HLF, which are intended to lessen the risk of environmental impact to the local soils, surface water, and ground water. An underdrain system was designed for the foundation of the HLF to capture potential spring water and transport it to the toe of the process pond fill. Mr. Minard also sited and designed a lined gypsum pond to manage a gypsum slurry that will be produced as a by-product of the SART operations.

Project Manager and Lead Design Engineer
Ağı Dağı Project, Alamos Gold Inc., Turkey

Project Manager and Lead Design Engineer for the design of a 1.3 million square meter (m2) geomembrane lined leach pad that is designed to process 82.2 million tonnes of ore. The Ağı Dağı Project is a gold and silver mine development project located in the Biga Peninsula in the province of Çanakkale, in north-western Turkey. Supporting work involved geotechnical characterization of the site, and storm water control.

Project Manager and Design Engineer
Ruby Hill Mine – 426 Heap Leach Facility Expansion, Barrick Gold, NV

Project Manager and Design Engineer for the design of a 1.2-million-square-foot expansion of the heap leach facility to process 7.2 million tons of gold baring ore stacked to 200 feet. Included design of geosynthetic liner systems, two-cycle leachate collection systems, leak detection systems, and solution and overflow pond. A deterministic water balance was prepared for pond sizing and to estimate return water and make-up water requirements. Prepared design drawings, technical specifications and supporting design documents.

Senior Design Engineer
La Colorada, Argonaut Gold, Hermosillo, Mexico

Senior Design Engineer for feasibility and construction design of a four additional phases of leach pad expansion. The leachate solution from the addition phases will flow via gravity to new ponds. Mr. Minard prepared a water balance to optimize the use of existing ponds, and to size the new ponds. Due to property boundary limitations the additional expansions extended over steep grades (greater than 2 Horizontal to 1 Vertical). To facilitate construction in the steep grades a geosynthetic clay liner (GCL) was placed below the LLDPE geomembrane liner. The design also included a geomembrane lined conveyor corridor.

Project Manager and Senior Design Engineer
El Castillo Mine - Cell 8, Argonaut Gold, Durango, Mexico

Project Manager and Senior Design Engineer for the feasibility study, design, of a multi-celled leach pad expansion for processing gold ore. Included civil grading design of to mitigate large fill slopes in steep terrain, working with mine plan to optimize local borrow and economical use of mine waste.

Senior Design Engineer
El Castillo Mine – La Victoria Pad, Argonaut Gold, Durango, Mexico

Senior Design Engineer for the feasibility study and construction design of the La Victoria leach pad expansion. The La Victoria Pad is confined by existing leach pads on 3 sides, and the pad was constructed over the footprint of the mined-out La Victoria Pit. Included design of geosynthetic liner systems, leachate collection systems, leak detection systems, and calibrating the existing water balance to evaluate if additional pond storage capacity is required. Mr. Minard conducted an extensive settlement and stability analysis, including evaluation of site mine waste material that was used as pit backfill prior to leach pad construction.

Project Manager and Senior Design Engineer
San Agustin Mine – Heap Leach Facility, Argonaut Gold, Durango, Mexico

Project Manager and Senior Design Engineer for the green field development and construction of the heap leach facility. Included design of geosynthetic liner systems, leachate collection systems, leak detection systems, and solution collection ponds. Prospected, investigated, and delineated material borrow sources and designed stormwater diversion facilities. Mr. Minard developed a deterministic water balance for pond sizing and to estimate return water and make-up water requirements. During the operation Prepared a grading plan and design documents. Mr. Minard made several site visits during construction to evaluate the client's third-party Quality Assurance Testing program.

Project Manager and Design Engineer
Hycroft Mine – Tailings Storage Facility, Hycroft Mining, Sulfur, NV

Served as project manager and design engineer for the design from Scoping Study through Feasibility Design to store 730 million tons of gold tailings. The project involved site selection and conceptual design of the dam and lined impoundment, as well as design of tailings delivery and water return pump/pipe systems. Site selection was based on capital and operating costs, as well as the non-cost selection criteria of geotechnical risk, environmental risk, regulatory acceptance, and construction risk. As water supply was a critical issue, Mr. Minard developed several water balances to predict water usage planning and return water system design. Mr. Minard conducted tailings consolidation testing and used analytical modelling to estimate the final dry density and beach slope of the subaqueous deposited tailings. Deliverables included development of design drawings showing staged development of the dam, lined basin, and storm water controls, as well as documents required for NEPA permitting support.

Tailings Management Facilities

Project Manager
Pumpkin Hollow Dry Stack Tailings Facility Test Cell, Nevada Copper Inc, Yerington, NV

Served as project manager for Pumpkin Hollow DSTF Test Cell design and construction. The Test Cell is a standalone facility designed to store 140,000 tons of filter press tailings. The facility was designed and constructed without a geomembrane base liner; the base was composed of 12 inches of compacted tailings. The design included an extensive instrumentation and monitoring plan, which included a combination of lysimeters, volumetric moisture sensors and matric potential sensors. Deliverables included issued for construction drawings, technical specifications, construction inspections/testing, and a post construction Record of Construction Report.

Project Manager
Bomboré Hybrid Facility, OreZone Gold Corporation, Burkina Faso, Africa

Served as project manager for Bomboré's Hybrid Facility, from concept through feasibility design. The Hybrid Facility is a single facility designed to store 33.5 million tons of gold tailings and process 31.5 million tons of gold baring ore on a lined leach pad. A "scrubber" separation process is applied to the mined ore to generate coarse material that is process via the heap leaching operation and fine material that is sent to a CIL tank leaching circuit. The residue from the CIL operation is discharged as tailings. The heap leach ore will be contained and processed on a geosynthetic lined surface. The tailings will be contained within a geosynthetic lined impoundment formed by compacted waste rock fill on 60% of the perimeter and by the conveyor-stacked heap leach ore on the remaining 40% of the perimeter. Deliverables included Trade-off studies, and several reports (scoping, prefeasibility and feasibility). Studies Include; Site Characterization, Tailings Characterization, Heap Leach Ore Characterization, Stability and Settlement, Mass Balance, Water Balance, Gravity Pipe Design, Pipe Crushing Analysis.

Project Manager and Design Engineer
Randall's Integrated Waste Landform (TSF & WRD), Integra Mining, Western Australia

Served as project manager and design engineer for the Randalls' Integrated Waste Landform, from concept through feasibility design and construction. The integrated waste landform was designed to store 4.3 million tons of gold tailings and 5.2 million tons of waste rock in a single integrated facility. Deliverables included Trade off studies, and several reports (scoping, prefeasibility and feasibility) and Construction Documents (drawings and technical specifications).

This project was presented at the Mine Waste 2010 Conference in Perth Australia; "An environmentally and economically attractive integrated landform for the storage of tailings and waste at the Randalls Gold Project in Western Australia".

Project Manager and Design Engineer
Paddington In-Pit Tailings Storage, North Gold Fields Limited, Kalgoorlie, Western Australia

Served as project manager and design engineer for the Feasibility Design to place tailings into the mined-out Paddington Pit to accommodate 56 Mt of tailings over 14 years of deposition. Mr. Minard conducted tailings characterization testing and used analytical modelling to predict the tailings performance during operations from being discharged into the pit from a single point. Mr. Minard managed several studies including a hydrogeological study and seepage analysis to assess the response of the groundwater system for conditions prior to, during, and following tailings deposition. Deliverables included development of a design report, which included Drawings, Tailings Characterization, Geotechnical Hazard Assessment (including Rapid Drawdown Assessment), Consolidation Modelling, Seepage Analyses, Water Balance, Surface Water Management, Emergency Action Plan and Decommissioning and Rehabilitation Recommendations.

Project Manager and Design Engineer
Wiluna Uranium Project – Heap Leach Facility, Toro Energy, Western Australia

Served as project manager and design engineer to provide technical support and design of a uranium trial heap leach facility at the Wiluna Uranium Deposit in Western Australia. The design was prepared to support a Mining Proposal. The heap leach process consisted of placing uranium-rich ore on a lined pad, and then irrigating the ore with sodium carbonate. The pregnant solution is collected above the lined pad via a gravity drainage system, which will direct the solution to a lined Pregnant Liquor Solution Pond. The

liquor is cycled through the heap several times until the liquor achieves the targeted concentration of uranium at which time the leaching ceases and rehabilitation and closure of the heap leach facility begins. Deliverables included development of a Mining Proposal Report, which included Drawings, Site Characterization, Ore Characterization, Geosynthetic Liner, solutions collection, Leak Detection, Stability Assessment, Seepage Management, Stormwater Management (including Flood Protection), Environmental Impacts and Management (including Radiation and Air Emissions), and Rehabilitation and Closure.

Design Engineer
Uranium Tailings Management, Client: Confidential, Australia

Served as design engineer for the site selection and storage concepts of the storage of 9.6 million tonnes of Uranium tailings, which would be produced in two productions streams (7.0 Mt of tailings and 2.6 Mt of slimes). Deliverables included development of a Scoping Study Report, which included Drawings, Tailings Characterization, and Water Balance.

Project Manager and Design Engineer
Mt. Keith Central Discharge Tailings Storage, BHP Billiton, Western Australia

Served as project manager and design engineer for the Life-of-Asset Planning for the centralized discharged tailings storage facility consisting of a containment embankment that has a diameter of approximately 2.9 miles (4.6 k). The tailings storage facility had been operating for approximately 13 years and Mr. Minard was consulted to evaluate the operations and safety of the facility, including tailings deposition and embankment construction.

Design Engineer
Phoenix Mine – Stage 3 Tailings Impoundment, Newmont Mining Corporation, NV

Design Engineer for the design of Stage 3 Tailings Impoundment Facility (a 20-foot-high raise and lined impoundment) for combined gold and copper mill tailings. The project included extending the gravity decant system, liner and drainage systems design, stormwater diversion design, facility sizing and layout, and preparation of construction drawings, specifications, and an Engineer's cost estimate. Following the design Mr. Minard served as the project manager during Stage 3 construction. The design incorporated an HDPE geomembrane liner in the impoundment as well as an overlying hydraulic relief layer. Staged dam expansion used both downstream and centerline raise construction techniques.

Project Engineer
Twin Creeks - Piñon Tailings Dam, EAP, Newmont Mining Corporation, NV

Project Engineer for the preparation of an Emergency Action Plan (EAP) for the Piñon Tailings Dam. The project included a notification flowchart, inundation map, preplan work sheets, and technical analysis of dam break flood (DAMBRK software by Boss International). Breach parameters were chosen based on guidelines established by the Federal Energy Regulatory Commission (FERC) for earth dams. Additionally, Mr. Minard's analysis and formal application was successful in re-classifying the Piñon Dam from "significant hazard" to a "low hazard".

Project Engineer
Willow Creek Reservoir, EAP, Newmont Mining Corporation, NV

Project Engineer for the preparation of an Emergency Action Plan (EAP) for the Willow Creek Dam. The project included a notification flowchart, inundation map, preplan work sheets, and technical analysis of dam break flood (DAMBRK software by Boss International). Breach parameters were chosen based on guidelines established by the Federal Energy Regulatory Commission (FERC) for earth dams.

Project Engineer
Phoenix Tailings Dam, EAP, Newmont Mining Corporation, NV

for the preparation of an Emergency Action Plan (EAP) for the Phase 7 Tailings Dam. The project included a notification flowchart, inundation map, preplan work sheets, and technical analysis of dam break flood (DAMBRK software by Boss International). Breach parameters were chosen based on guidelines established by the Federal Energy Regulatory Commission (FERC) for earth dams.

Project Engineer
Midas Mine – Ken Snyder Dam, EAP, Midas, NV

for the preparation of an Emergency Action Plan (EAP) for the Phase 5 Tailings Dam. The project included a notification flowchart, inundation map, preplan work sheets, and technical analysis of dam break flood (DAMBRK software by Boss International). Breach parameters were chosen based on guidelines established by the Federal Energy Regulatory Commission (FERC) for earth dams.

Mine Reclamation and Closure

Design Engineer
McLaughlin Mine – Tailings Impoundment Closure, Barrick Gold, CA

Design Engineer responsible for the closure design and closure implementation of a 44 million ton tailings storage facility. Evaluated closure options for both drained and ponded closure scenarios, considering effects from earthquake-induced liquefaction settlement of the final closed surface, the long-term reliability of the dam, long-term environmental impacts. Developed drawings and specifications for placement of the closure cover, as well as rehabilitation design of storm water diversion facilities.

Transportation

Project Manager
Stead Airport – Runway 14-32 Reconstruction, Reno-Tahoe Airport Authority, Reno, NV

Responsible for completing plans, specifications and estimate (PS&E), as part of a team. Project scope included portions of the civil engineering design and construction administration assistance for reconstruction and extension of Runway 14-32. This runway is 9000 feet long and 150 feet wide designed for airplane design group III-C aircraft. Direct responsibilities included oversight of civil design for Hot-Mix Asphalt (HMA) jointing, drainage design, demolition and construction management.

Project Engineer
Stead Airport – Taxiway A and D Realignment and Taxiway Lighting, Reno-Tahoe Airport Authority, Reno, NV

Project scope included the development of plans, specifications, estimate, engineering report, construction support services, record drawings and Construction Report for this project. Project included demolition and realignment of two existing taxiways. To meet FAA requirements a mile of an existing access road was also realigned. Major design considerations included; onsite and offsite hydrology, modification of existing monitoring wells, grading striping per FAA design criteria, and many access and scheduling restrains.

Project Engineer
USPS Apron Development, Reno-Tahoe Airport Authority, Reno, NV

This project consisted of preparing plans, specifications, engineer's reports as well as construction service for the reconstruction of an apron area on the northwest portion of the Reno/Tahoe International Airport. The plans for this apron were developed in an emergency timeline, and Mr. Minard completed the design prior to the stated deadline. Was responsible for the drainage design, inlet capacity, engineering estimate, design details, records drawings and final report.

Staff Engineer
South Terminal Apron Rehabilitation, Reno-Tahoe Airport Authority, Reno, NV

The project consisted of the demolition of an unusable Asphalt Concrete ramp area and replacement with a new portland cement concrete (PCC) pavement apron. Was responsible for the drainage design, inlet capacity, engineering estimate, design details, records drawings and final report. Was also responsible for the sizing and construction of an oil/water separator (Stormseptor).

Staff Engineer
Sealcoat and Stripe Runway, Reno-Tahoe Airport Authority, Reno, NV

Project scope included development of the plans, specifications, estimate, engineering report, construction support services, record drawings and Construction Report for this project. Project included placing an emulsified asphalt sealcoat to the surface of two existing runways at the airport. Responsible for construction engineering.

Project Engineer
Wells Avenue Rehabilitation, Nevada RTC, Reno, NV

Major work items include removal and replacement of curb, gutter, sidewalk, driveways, pedestrian ramps; removal of existing bituminous surface; subgrade preparation; base placement; cement roadbed modification; placement of bituminous surface; Roundabout construction; signal work; striping; traffic control; and incidentals as required to complete the work for approximately 10,000 LF of arterial roadway in the City of Reno. Responsible for completing plans, specifications and estimate (PS&E) for project, which included, drainage improvements, complete roadway reconstruction and public involvement. Performed complete construction administration including submittal review of traffic control plans and construction schedule. Responsibilities included inspection and testing of material and construction process.

Project Engineer
Neighborhood Streets Rehabilitation, City of Reno, Reno, NV

Mr. Minard supported the City of Reno with their neighborhood streets rehabilitation program, including 2003, 2000, 1999, 1997 and 1996. Project scope included field surveys, geotechnical investigation, laboratory testing, pavement design, pavement condition surveys, special assessment district make-up, Phase I Environmental Investigation, PS&E (plans, specifications & estimate) and complete construction administration services. Responsibilities included inspection of curb, gutter, sidewalk and asphalt pavement; pavement sections selection, design all grades and alignments; developing an engineer's estimate; providing construction plans and specifications; resident engineer during construction; final report; and as-built record drawings.

Project Engineer
McCarran Boulevard Rehabilitation, Nevada RTC, Reno, NV

The major work items include removal and replacement of curb, gutter, sidewalk, driveways, pedestrian ramps; removal of existing bituminous surface; subgrade preparation; base placement; cold in place recycled asphalt concrete; cement roadbed modification; placement of bituminous surface; sound wall; signal work; guardrail; striping; traffic control; and incidentals as required to complete the work for approximately 34,000 lf of arterial roadway in the City of Reno. Responsible for completing plans, specifications and estimate (PS&E) for project, which included, drainage improvements, complete roadway reconstruction and public involvement. Performed complete construction administration including submittal review of traffic control plans and construction schedule. Responsibilities included inspection and testing of material and construction process.

Project Manager
Lemmon Drive Reconstruction, Nevada RTC, Reno, NV

Responsible for completing plans, specifications and estimate (PS&E) for project, which included drainage improvements, subgrade preparation; base placement; cement roadbed modification; placement of bituminous surface; striping; traffic control; and incidentals as required to complete the work for approximately 3 miles of rural two-lane roadway in Lemmon Valley. Performed complete construction administration including submittal review of traffic control plans and construction schedule. Responsibilities included inspection and testing of material and construction process.

Project Manager
Sullivan Way Reconstruction, Nevada RTC, Reno, NV

Responsible for completing plans, specifications and estimate (PS&E) for project, which included drainage improvements, complete roadway reconstruction, cold in place mill and asphalt pavement overlay rehabilitation, public involvement and incidentals as required to complete the work for approximately one mile of roadway in the City of Sparks. Performed complete construction administration including submittal review of traffic control plans and construction schedule. Responsibilities included inspection and testing of material and construction process.

Staff Engineer
Arlington Avenue Reconstruction, Nevada RTC, Reno, NV

Assisted with plans, specifications and estimate submittal to the Regional Transportation Commission (RTC) for the rehabilitation of approximately 3,000 feet of roadway in downtown Reno, Nevada. Some of these aspects are five signalized intersections including one intersection managed by the Nevada Department of Transportation, a railroad crossing and a hospital emergency entrance. Also responsible for complete construction management of the project as required by the RTC and provided separate plans for curb, gutter and sidewalk for assessment district (SAD).

Staff Engineer
Center Street Reconstruction, Nevada RTC, Reno, NV

Project scope included engineering services for the rehabilitation and reconstruction of Center Street, a two-lane roadway, from Mill Street to South Virginia Street (approximately 4,760 feet) in the City of Reno. During construction provided contract administration, resident engineering and engineering construction services. Responsibilities included inspection of curb, gutter, sidewalk and asphalt pavement; and preparing engineers estimate.

Infrastructure

Project Manager
Portable Classroom Project, Washoe County School district, Reno, NV

Provided engineering design services for construction of portable classrooms at 13 local elementary schools for the Washoe County School District. Services included site design, surveying, utility coordination, cost estimating, preparation of plans and specifications and construction assistance. The focus of this project was the extremely quick turnaround to meet the client's tight construction schedule and Mr. Minard's team completed all work within identified deadlines.

Project Engineer
Water Main & Street Design, City of Live Oak, CA

Prepared PS&E (plans, specifications & estimate) for the water main replacement, street and sidewalk reconstruction for Connecticut Avenue, including parking lot improvements for the Luther Elementary School in Live Oak, California.

Project Manager
High School Tennis Courts, Washoe County School District, Reno, NV

Mr. Minard supported the Washoe County School District with the design and construction of several tennis courts, including: Proctor R. Hug High School, Incline High School, Reed High School, and McQueen High School. Project Engineer for the reconstruction of the several tennis courts, which involved an asphalt concrete (AC) pavement surface, color-coated surface, net post and replacing surrounding fencing fabric. Responsibilities included preparing plans, specifications, cost estimate (PS&E), and construction management for site design, court surface, net and surrounding fence.

Project Engineer
Reed High School Parking Lot, Washoe County School District, Reno, NV

This project involved the reconstruction of the Reed High parking lot, which involved pulverizing existing asphalt concrete, grading, and asphalt concrete (AC) pavement surface. Responsibilities included preparing plans, specifications and cost estimate (PS&E) for site design, court surface, net and surrounding fence.

Hydrology and Hydraulics

Staff Engineer
Design of the Pabco Road Erosion Control Structure, Clark County, Las Vegas, NV

This structure is the first of 15 erosion control structures planned for the Las Vegas Wash to stop the advancement of a severe headcutting erosion condition, which threatens local wetlands and upstream public improvements. This $1.8 million low height, gabion weir is being designed as a three-stage overflow spillway structure, 1,150 long and is capable of passing in excess of the 500-year frequency discharge of 24,000-cubic-feet per second. Responsibilities included gabion sizing and design, and channel sizing using HEC-2.

Staff Engineer
Sunrise Mountain Landfill Closure, Clark County, NV

Responsibilities included hydrology and hydraulic analysis for sizing and placement of a rainwater runoff collection system and transporting the water to an offsite location. Was also responsible for the design of a large energy dissipation channel.

Staff Engineer
Lake Mead Boulevard Drainage Design, City of Henderson, Southern Nevada

Project scope included the hydrologic analysis and hydraulic design of all roadway drainage improvements including drop inlets, parallel channel design, cross roadway drainage conveyance, inlet and outlet energy dissipation and erosion control designs. Responsibilities included off site hydrology to determine peak discharge, design of roadside ditches and storm drain system which included calculating capacity of drop inlet grate. Responsibilities also included producing storm drain schedule, structures list and engineers estimate.

Project Engineer
State Route 28 Drainage and Erosion Control Design, Nevada DOT, Lake Tahoe Basin, NV

Project scope included the drainage report, plans, specifications and cost estimates for the drainage, erosion/sediment control and slope stabilization related components of the design. Responsibilities included determining off site hydrology to calculate peak discharge, design of roadside ditches, storm drain system which included calculating capacity of drop inlet grate and sizing sediment traps. Responsibilities also included producing storm drain schedule, structures and engineers estimate.

Staff Engineer
Boneyard Flat Feasibility Design, city of Sparks, Spanish Springs Valley, Nevada

This project consisted of developing a feasibility plan to divert storm water runoff from Griffith Canyon to Boneyard Flat to decrease the peak flows and runoff volume contributing to downstream development and the City of Sparks. Responsibilities included designing three feasible alternatives for collecting 100-year storm event and transporting it past a proposed subdivision and releasing it into the Boneyard Flat area. The channel was placed in three alignments which considered existing topography, right of way cost and availability, utilities including a 30-inch high pressure gas main, and structures required to cross existing roads including Pyramid Highway. Was also responsible for producing design plans, details and an engineer's estimate.

Staff Engineer
Truckee River Bridge at Patrick Interchange, Nevada DOT, Washoe and Storey Counties, NV

Responsibilities included producing a computer model of the Truckee River using HEC-2 to match existing FEMA model, and to show impact of bridge structure on flood plain.

Technical Lead
Carson River Valley, University of Nevada Reno, NV

Study the chemical and mineral transportation of the Carson River Valley. Responsibilities include modeling the Carson River in WASP (computer software for modeling water quality and quantity) and sampling of the river

Staff Engineer
Pavement Management System

Mr. Minard implemented many pavement management programs for several Counties, cities and Army basis, including Aberdeen Army Depot (Maryland), Fort Belvoir (Virginia), West Point Military Academy (Ney York), City of Modesto (California), County of Lake (California) Sierra Army Depot (California), Tracy Army Depot (California), Sharpe Army Depot (California). Responsibilities included, inspections, or re-inspections, of pavement network, setting up the data base (MTC or Paver software) and development of network level five year maintenance and repair plan.

Peter H. Yuan, PE, PhD
Senior Associate Geotechnical Engineer

Summary

Years of Experience

17+

Office of Employment

Reno, NV, United States

Professional Summary

Mr. Yuan currently serves as a Senior Associate Geotechnical Engineer in Wood Environment & Infrastructure Solutions Inc's Reno office. He has about 17 years of geotechnical and civil consulting experience. He is specialized in soil mechanics, foundation engineering, and surface mine facility design.

Mr. Yuan's project experience includes design of tailings impoundments, heap leach pads, and mine waste disposal facilities; infrastructure foundations; seismic design and liquefaction analysis; slope design, remediation, and monitoring instrumentation; construction monitoring and quality control; and geotechnical numerical modelling. His experience also includes studies from scoping levels to closures and projects located throughout North America, South America and Asia.

Mr. Yuan authorized and co-authored more than 20 technical papers published in engineering journals and conference proceedings on slope design, lined facility design, soil liquefaction and ground damage, and other geotechnical engineering topics.

Qualifications

Education

PhD/Geotechnical Engineering/Clemson University/2003

MSc/Geotechnical Engineering/Zhejiang University/2000

BS/Civil Engineering/Zhejiang University/1997

Registrations / Certifications / Licenses

Professional Engineer/NV/#019348

Professional Engineer/CA/#69618

Professional Engineer/AZ/#58253

Professional Engineer/ID/#16913

Languages

- English

Representative Experience

Lead engineer

Thacker Pass Lithium Project, Lithium Nevada Corp, Humboldt County, Nevada

Lead engineer for an independent review of a dry stack Tailings Storage Facility design, along with performing a geotechnical characterization program of lithium tailings. Lead engineer for a geotechnical foundation investigation supporting a feasibility study (FS) design of a Rail Transloading Facility, as a part of the Thacker Pass Project.

Lead engineer and EOR

North Waste Rock Disposal Facility Cover Improvement Project, Rain Mine Site, Nevada Gold Mines, NV

Lead engineer and EOR for this closure project to improve a cover system over a 75-acre area of a waste rock disposal facility. Scope of services includes design of a cover system involving geomembrane/soil covers, a surface water drainage system, and preparation of an addendum to the Final Plan for Permanent Closure (FPPC).

Lead Geotechnical Engineer

ASARCO/Southern Copper Corporation, Multiple Projects in Peru and Mexico

Lead geotechnical engineer for an ongoing review project involving tailings storage facilities, heap leach facilities and waste storage facilities (where applicable) of multiple mining projects, including Torquepala, Cuajone, Tia Maria, Los Chancas (Peru) and El Arco (Mexico). Upon completion of the project, to serve as a Qualified Person (QP) for the TSF, HLF, and WRD of each S-K 1300 Technical Report.

Dam Safety Inspections as Lead Engineer

McLaughlin Mine, Homestake Mining Company (Barrick), CA

Lead geotechnical engineer (through year 2013) for multiple mine closure projects that involve a tailings impoundment, a water dam, two open pits, multiple waste dumps and sediment control ponds. Performed annual geotechnical audits, dam safety inspections as Lead Engineer, and monitoring reviews of all dam structures, including a Davis Creek Reservoir Dam.

Lead Engineer and EOR

Bunker Hill Central Treatment Plant Upgrade Project, Kellogg, ID

Lead engineer and EOR for design of a 10-acre lined sludge impoundment with a tailings impoundment. Lead geotechnical engineer for a foundation investigation in support of water treatment infrastructure facility designs.

Dam Safety Review and Third-Party Review

Santa Rita Mine, Atlantic Nickle/Appian Capital Advisory, Bahia, Brazil

Project manager and lead engineer for performing a dam safety review and third-party design review of a tailings storage facility. Technical reviewer for detailed engineering designs of the TSF raises and conceptual design of a new TSF. Qualified Person (QP) for the TSF portion of the NI 43-101 Technical Report.

Lead Geotechnical Engineer

Tracy Power Generating Station, NV Energy, NV

Lead geotechnical engineer and designer for Tracy Pond 4 design and provided permit support and CQA. The project is classified as a jurisdictional impoundment and dam in Nevada. Peter also provided geotechnical and civil design services for NV Energy on multiple other infrastructure facilities across the State.

Lead designer and geotechnical engineer

Confidential Mine Closure and Remediation Project, Lyon County, NV

Lead designer and geotechnical engineer of Remedial Design / Remedial Action (RDRA) task for fluid management system designs and regrade/cap designs of five (5) heap leach facilities. Responsibilities included supervising geotechnical characterization, RD activities, as well as providing miscellaneous geotechnical support for this large remediation and mine closure project. Lead geotechnical engineer for Remedial Investigation/Feasibility Study (RI/FS) activities of five (5) other Operable Units, including tailings storage facilities, evaporation ponds, and waste storage areas.

Project manager and geotechnical engineer

Goldstrike Arturo Project, Nevada Gold Mines, Inc, NV

Project manager and geotechnical engineer (through year 2017) for providing design, geotechnical studies and/or construction quality control/assurance services in support of miscellaneous infrastructure development, including heap leach pad, ore stockpile pad, ponds, electrical substation, explosives magazines, fueling bay, stormwater dam, silos, and others.

Geotechnical and civil engineer

Pinto Valley Mine, Capstone Mining Corp, AZ

Geotechnical and civil engineer participating in three prefeasibility-level designs of tailings storage expansions. Lead civil engineer for construction-level designs of multiple earthen embankment dam raises and boundary dam raises.

Lead geotechnical engineer and project manager

Gold Quarry Mine, Nevada Gold Mines, NV

Lead geotechnical engineer and project manager for a geotechnical study evaluating interaction between a gyro crusher foundation and pit slope layback. Lead geotechnical engineer and project manager for a truck shop foundation mitigation project. Lead geotechnical engineer and project manager for design of a lined ore stockpile pad to receive concentrate ore material; project reviewer for relocating an escape way and extending a reclaim tunnel of a mill crushing circuit. Technical reviewer for CQA of a Mill 5/6 East tailings storage facility expansion.

Project manager and lead engineer

Serrote Copper Project, Mineração Vale Verde/Appian Capital Advisory, Alagoas, Brazil

Project manager and lead engineer for performing a peer review of a tailings storage facility with the earthen starter dam also planned to be used for mine start up water. Project reviewer for Phase 1 detailed engineering designs of the TSF.

Civil/geotechnical engineer and project manager

CSH Project, Jinshan Gold Mines, Inner Mongolia, China

Civil/geotechnical engineer and project manager for design and construction of a heap leach facility, two bankable feasibility level studies of new expansions/heap leach facilities; also participated in foundation designs for multiple surface mining facilities.

Geotechnical engineer

Permanente Quarry, Lehigh Southwest Cement Company, CA

Geotechnical engineer for designs of multiple waste dumps, topsoil stockpiles, and open pit slopes involving weak rocks and soils. Participated as the lead geotechnical engineer for preparation of the mine closure plan.

Lead geotechnical engineer and project manager

Cortez Mine, Nevada Gold Mines, NV

Lead geotechnical engineer and project manager for a geotechnical study in support of ore characterization and buttress design for a heap leach facility; lead geotechnical engineer for miscellaneous projects related to ground subsidence studies, foundation investigations, tailings seismic design practice reviews, and an in-pit backfill study.

Geotechnical engineer

Confidential Mine Closure and Remediation Project, CA

Geotechnical engineer for a site-wide geotechnical study in support of a Remediation Investigation and Feasibility Study (RI/FS) program on an environmental remediation and closure project. Responsibilities included developing a work plan for site geotechnical characterization, landslide investigation and monitoring, preparation of preliminary designs for ponds and a sludge impoundment, as well as providing miscellaneous geotechnical support for RI/FS operations.

Lead designer and task manager

Rhyolite Ridge Lithium-Boron Project, Paradigm Minerals USA, Nevada

Lead designer and task manager for design of a drystack tailings storage facility as a part of a prefeasibility study (PFS) for this greenfield project. Responsibilities included leading several trade-off studies for waste management options and a PFS design for dry-stacking residue material from leaching along with other waste materials.

Geotechnical professional

Kidd Operations Intergraded Closure Project, Ontario, Canada

Geotechnical professional leading a feasibility level closure design for the tailings management area; responsibilities included development of tailings deposition plans, civil designs of tailings covers, and berm raises, and preparation of construction tender packages.

Project manager and geotechnical engineer

Goldstrike Betze-Post Northwest Layback Project, Nevada Gold Mines, NV

Project manager and geotechnical engineer for foundation investigations in support of powerline relocation and silo relocation projects. Geotechnical engineer overseeing the construction quality assurance services for the SWE secondary containment pad construction and silo installation.

Project manager

Goldstrike Mine Banshee Project, Barrick/DMC Mining Services, NV

Project manager for providing geotechnical engineering, construction quality assurance, and field engineering services for a 1200-foot-deep ventilation shaft sinking project.

Geotechnical engineer and project manager

Turquoise Ridge Mine, Barrick/DMC Mining Services NV

Geotechnical engineer and project manager for a foundation investigation in support of the design of an underground backfill plant and appurtenance surface facilities. Geotechnical engineer for a foundation investigation and CQA services in support of multiple ventilation fan structures founded on non-engineered fill.

Geotechnical engineer

Lone Tree Mine, Nevada Gold Mines, NV

Geotechnical engineer for the design of the Stages 11 and 12 tailings impoundment expansions. Also participated in several other projects that involve heap leach facility designs, open pit slope studies and waste dump stability reviews.

Lead geotechnical engineer and project manager

Twin Creeks Mine, Nevada Gold Mines, NV

Lead geotechnical engineer and project manager for providing design and field engineering services for a tailings closure project (Pinion Tailings Storage Facility).

Lead geotechnical engineer and/or project manager

Golden Sunlight Mine, Barrick Golden Sunlight Mines, MT

Lead geotechnical engineer and/or project manager for multiple engineering projects, including mine waste dump designs, open pit designs, tailings storage facility siting studies, and landslide monitoring and remediation.

Lead geotechnical engineer

Phoenix Mine, Nevada Gold Mines, NV

Participated in design and construction of a tailings storage facility with an ultimate capacity of 290 million tons of tailings (through year 2013). Lead geotechnical engineer for tailings impoundment instrumentation, and for foundation designs of several mining facilities, including crushers, mill, and laboratory buildings. Performed a site-wide geotechnical audit for mining infrastructure, including the tailings impoundment and heap leach facility.

Lead geotechnical engineer and project manager

Yanacocha Mine, Minera Yanacocha S. R. L. (Newmont), Peru

Lead geotechnical engineer and project manager for a civil/geotechnical study to support the design of a large in-pit waste disposal facility and several pit slope movement remediation projects. Participated in periodic slope design practice reviews.

Geotechnical engineer and project manager

Kori Chaca Project, Empresa Minera Inti Raymi S.A./Newmont, Bolivia

Geotechnical engineer and project manager and provided engineering support in the design and development of the Kori Chaca pit and the subsequent Southwest Expansion. This project involves development of slopes in weak alluvial deposits that were submerged under water prior to mining. Also served as project manager for a site-wide geotechnical review in support of development of a mine closure plan; the involved facilities included several open pits, waste dumps, a tailings impoundment, two heap leach facilities, and flood protection dikes.

Lead engineer

Merian Project, Newmont Mining Corporation, Suriname

Lead engineer for design of saprolite slopes in support of a pre-feasibility-level study and a feasibility-level study. Design of multiple open pits of which the upper slopes up to 100m (or 330ft) high are to be developed in saprolites with shallow pre-mining groundwater tables and challenging hydrogeological settings for depressurization. Duties included supervising geotechnical investigation and strength characterization, performing stability analyses, and providing recommendations of saprolite slope design.

Lead engineer and project manager

Homestake Mine Closure Project, Homestake Mining Co., Lead, SD

Lead engineer and project manager (through year 2013). Performed biannual stability reviews and monitoring instrument installation and prepared a geotechnical monitoring plan for the open pit and mine waste disposal facilities. Also served as lead engineer and project manager on a slope remediation project for a landslide within a waste disposal facility; duties included performing geotechnical site characterization, monitoring instrument installation and data review, stability evaluation, preparing a civil design package, and providing engineer support and Construction Quality Assurance (CQA) management during construction.

Technical reviewer

Coeur Rochester Mine, Coeur Rochester Inc, NV

Technical reviewer for Construction Quality Assurance services in support of the Stage IV Overland Conveyor construction project. Geotechnical engineer leading a foundation evaluation in support of a concrete vault construction.

Miscellaneous Review Projects

Mr. Yuan has also been involved in many other internal or external review/audit projects that involve tailings storage facilities (TSFs) and heap leach facilities (HLFs), including:

- Newmont's Cripple Creek Mine HLFs (Colorado)
- Freeport-McMoRan's Morenci Producer Leach Stockpile PFS Project (Arizona)
- NOVAGOLD's Donlin Creek Gold Project TSF, Waste Rock Dump, and Water Dams (Alaska)
- PVDC's Pueblo Viejo TSF (Dominican Republic)
- Nevada Copper's Pumpkin Hollow Project TSF (Nevada)
- Alamos's Agi Dagi and Kirazli HLFs (Turkey)
- Hycroft's HLFs (Nevada)
- La Herradura's Heap Leach Project (Mexico)
- Dipolos' Heap Leach Project (Mexico)
- Oyu Tolgoi's TSF (Mongolia)
- Endeavor Silver's Bolanitos TSF raise (Mexico).

Omar Smith, PE
Senior Civil Engineer

Summary

Years of Experience

13

Office of Employment

Phoenix, AZ, United States

Areas of Expertise

- Hydrologic and Hydraulic Analyses and Design
- Site Grading and Drainage
- Quantity Take-off / Cost Estimates
- Project Management

Training

- Mine Safety and Health Administration Certification (05/12/2020)
- American Council of Engineering Companies of Arizona LEAP Graduate (2018)

Professional Summary

Omar is a project civil engineer with 12 years of experience supporting the mining, power, and public sectors. Omar has worked on a variety of projects at numerous properties throughout Arizona, New Mexico, Nevada, Mexico, and South America. Omar has a strong civil engineering technical background with proven professional skills in site civil design, hydrologic and hydraulic (H&H) engineering design, three-dimensional computer-aided design (CAD), slope stability analysis, field engineering, construction Quality Assurance (QA), and quantity takeoff/cost estimates. Omar has a proven record of leading design teams (both local and remote) on small- and large-scale projects.

Qualifications

Education

BS, Civil Engineering, University of Arizona, 2007

Registrations / Certifications / Licenses

PE, AZ #61735

Society for Mining, Metallurgy, & Exploration

Publications / Presentations

- A New Chapter at Lluvia de Oro & La Jojoba Gold Reserve, Sonora Mexico, SME Arizona Conference, 2011.

Languages

- English
- Spanish

Wood Experience

Senior Civil Engineer/Civil Design Lead

Hayden AB-BC Stability Buttress Detailed Design - ASARCO, Hayden, AZ $165K (07/2020 – Present) 1720204021

Senior Civil Engineer and Civil Design Lead for the detailed design of the Hayden AB-BC TSF Stability Buttress. Design tasks include, but are not limited to, the design of a stability buttress and the rehabilitation of existing ponds, existing emergency drainage channel, and existing access road.

Senior Civil Engineer

Producer Leach Stockpile Pre-Feasibility Study – Freeport-McMoRan Copper & Gold, Morenci, AZ (09/2019 – 03/2020)

Senior Civil Engineer for the pre-feasibility design of a ROM leach stockpile and associated facilities. Design tasks include but are not limited to stockpile (grading, drainage, and liner design), stockpile collection berm and headwall, solution conveyance pipes, a PLS impoundment, and a Non-Stormwater Impoundment.

Other Experience

Mining

Civil Design Lead

Silver Basin Leach Stockpile Detailed Design - Phases I and II, Freeport-McMoRan Copper & Gold, Morenci, AZ (2016-2019)

Site Civil Design Lead for the detailed design of a ROM leach stockpile and associated facilities. Worked with Morenci management, Senior Technical Lead, and design team to design a stockpile (grading, drainage, and liner design), stockpile collection berm and headwall, solution conveyance pipes, a PLS impoundment, and a Non-Stormwater Impoundment. Other tasks included realignment of major haul road going through the project area. AECOM coordinated with Morenci personnel to develop the BADCT approach and identify a preferred alternative for the APP Application.

Project Engineer

Leach Pad Dewatering and Stabilization, Freeport-McMoRan Copper & Gold, Arequipa, Peru (2013)

Provided oversight of extraction well drilling, development, and construction. Prepared lithologic descriptions and conducted step-rate and constant-rate aquifer tests. Provided oversight and documentation for multiple drill rigs and work sites during 24-hour work operations to construct a well field for managing phreatic levels in a leach pad to improve seismic stability.

Project Engineer

Instrumentation Installation, Freeport-McMoRan Copper & Gold, Morenci, AZ (2013)

Instrumentation installation at the existing Tailings Storage Facility. Collected soil samples and maintained a drilling log. Quality assurance tasks included overseeing the drilling activities, as well as the installation of piezometer wells, inclinometer wells, and monuments.

Project Engineer

Instrumentation Installation, Freeport-McMoRan Copper & Gold, Green Valley, AZ (2012)

Instrumentation installation at the existing Tailings Storage Facility. Collected soil samples and maintained a drilling log. Quality assurance tasks included overseeing the drilling activities, as well as the installation of piezometer wells, inclinometer wells, and monuments.

Engineer

Gold Heap Leach Expansion, Lluvia de Oro Mine / Minera Columbia, Sonora, Mexico (2010-2012)

Conducted volumetric and slope stability analysis. Designed the heap leach pad solution collection system. Implemented three-dimensional CAD design methods and produced preliminary engineering drawings for review by the Secretariat of Environment and Natural Resources (SEMARNAT). Met with SEMARNAT in Hermosillo, Sonora, to present the project design and gained approval. Upon approval, developed the final design engineering drawings used for construction. Provided on-site QA support during the construction phase. Attended frequent mine meetings to provide technical assistance and subsequently worked on a new heap leach expansion.

Engineer

Copper Heap Leach Expansion, Carlota Mine / Carlota Copper Company, Miami, AZ (2011)

Designed an inter-lift drainage system for a heap leach facility. Main project goals were to increase stability by controlling in-heap pore pressures, increase solution recovery, and manage stormwater. Prepared a water balance model and design drawings as part of the final technical design report.

Engineer

Stream Diversion Design, San Dimas Mine / Primero Empresa Minera, Durango, Mexico (2010)

Performed the hydraulic analysis and preliminary design of a diversion for a river with a peak flow of 4,992 m3/s (1,000-year event). Used HEC-RAS with Civil3D to design a diversion channel through a selected meandering section of the river, while minimizing any negative hydraulic effects both downstream and upstream of the diversion channel segment. Prepared a technical design report and a design drawing package submitted for permitting purposes.

Engineer

Silver Heap Leach Expansion, Rochester Mine / Coeur Rochester Inc., NV (2010)

Conducted volumetric and slope stability analysis. Designed the heap leach pad solution collection system. Conducted contingency pond capacity and sizing analysis. Implemented three-dimensional CAD design methods and produced engineered design drawing package. Produced a project construction cost estimate.

Engineer

Gold Heap Leach Expansion, Round Mountain Mine / Round Mountain Gold Corporation, NV, (2008-2009)

Conducted pond and sump capacity and sizing analysis. Implemented three-dimensional CAD design methods and produced site grading plans and decommissioning plans. Provided on-site QA support during the construction phase. QA tasks included earthworks, 3 million square feet of high-density polyethylene liner installation, drainage pipe installation, and overliner placement. Other on-site tasks included safety and project progress meetings. Prepared a Record of Construction report for approval by the Nevada Division of Environmental Protection.

Engineer

Silver Heap Leach Expansion and Closure, Rochester Mine / Coeur Rochester Inc., NV (2008-2009)

Performed hydraulic analyses and Civil 3D design for conveyor-solution transport corridor for more than 50-million-ton silver heap leach expansion. Designed closure breach through the existing solution retention dikes and produced engineering quantity and cost estimates for heap leach drain down management at multiple leach pads. Performed slope stability analysis on the overall heap and dike configuration. Performed water balance and closure cost estimate.

Power

Project Civil Engineer / Deputy Project Manager

Kingbird Solar, First Solar Inc., Kern County, CA

Kingbird Solar is a 320-acre, 40 MW solar photovoltaic facility. Provided civil engineering and management support for the project. The project included grading and drainage design, fence design, access road design, move-on area design, drainage report, and stormwater pollution prevention plan. The project also included drainage design for significant offsite runoff that crossed though the site.

Project Civil Engineer / Deputy Project Manager

Astoria Solar, First Solar Inc., Kern County, CA

Astoria Solar is a 2,100-acre, 175 MW solar photovoltaic facility. Provided civil engineering and management support for project. The project included grading and drainage design, fence design, access road design, move-on area design, telecommunication conduit plan, operations and maintenance building site plan, drainage report, and stormwater pollution prevention plan. The project also included drainage design for significant offsite runoff that crossed through the site in multiple locations.

Project Civil Engineer

Power Plant in New Mexico, Ash Pond Closure

Provided engineering support for the closure of an approximate 165-acre wet ash impoundment. Developed the 3D CAD model used to produce the closure design; the 3D model was also used to develop the corresponding project quantities and cost estimate. The project included civil engineering design, preparation of bid documents, procurement bid support, and engineering design support during construction of the closure. The closure of the ash impoundment included grading of the impounded ash and perimeter embankments, construction of storm water channels and basins, soil cement buttress construction, soil cement spillway, and construction of an evapotranspiration soil cap. Engineering design support and oversight was provided during the construction phase of the project. A Record-of-Construction (As-Built) drawing-package was produced once the closure construction was completed.

Dams

Project Civil Engineer

McMicken Dam Rehabilitation Project, Flood Control District of Maricopa County (District), Maricopa County, AZ

Rehabilitation of the existing McMicken dam to eliminate safety issues, including subsidence and lowered dam crest, earth fissure risk zones, embankment cracking, foundation concerns, outlet pipe concerns, and emergency spillway adequacy. The project consists of the design of a fissure resistant soil cement embankment with cutoff walls (1 mile), upstream earthen embankment raise with sloping filter (7 miles), new concrete Principal Outlet, new concrete Emergency Spillway, and Outlet Channel modifications (6 miles). Design includes developing updated hydrology and hydraulic analyses for the reservoir and spillway, fissure erosion modeling, geotechnical investigations and stability of the earthen embankment, and strength and stability evaluations of geosynthetic components. Developed the 3D CAD model used to develop the design drawings, quantities, and cost estimates. Other tasks include but are not limited to technical writing, project coordination, and project stakeholder coordination. The 30 Percent Design for all five (Phase I through Phase V) phases of the project has been submitted, as well as the 100 Percent Design for Phase I of the project.

Project Civil Engineer

Utilities, Easements, and Rights-of-Way Appraisal for Phases I and II, Flood Control District of Maricopa County (District), Maricopa County, AZ

Prepared the Utilities, Easements, and Rights-of-Way Appraisal for Phases I and II for the McMicken Dam Rehabilitation Project. The project required coordination with utility entities and project stakeholders. The appraisal presented a review, summary, and indexing of data relevant to Phases I and II of the planned rehabilitation project. The appraisal also included all information previously collected, and any new data, for the entire McMicken Dam (9.5 miles) and the corresponding Outlet Channel (6 miles) project area.

Professional History

- Wood Environment & Infrastructure Solutions, Inc., Geotechnical Engineer, Phoenix, AZ, September 2019 - Present

Robert Starr Ph.D., P.E.

Senior Associate Hydrogeologist

Professional Summary

Dr. Starr has 39 years of environmental science and engineering experience. His primary expertise is in hydrogeology, particularly characterizing and remediating sites with contaminants in groundwater, soil, and the vadose zone. He has experience with various classes of subsurface contaminants, including volatile and semi-volatile organic compounds, dense and light non-aqueous phase liquids, metals and other inorganics, and radionuclides. He has conducted projects for private sector clients, on federal sites administered by DOE, DOD, NASA, the US Forest Service, and the Bureau of Land Management, and by state agencies. He has over two decades of experience with characterization and remediation in the CERCLA and RCRA regulatory programs. He provided technical support over a 14-year period to U.S. EPA remedial project managers on CERCLA projects, including performing data interpretation and analysis, transport modeling, conducting independent technical reviews of third-party submittals, and providing technical expertise at public meetings and during interactions with responsible parties, their consultants, and counsel. Dr. Starr conducted applied research in subsurface characterization and remediation techniques at a university research center and a national laboratory. His experience in subsurface remediation includes bioremediation, monitored natural attenuation, in situ chemical oxidation, and the use of cutoff walls and permeable reactive barriers. He managed research and consulting projects, technical teams, and external peer review panels for DOE projects. He is currently focused on a CERCLA remedial investigation and feasibility study at a former mine site where acid drainage has affected groundwater and surface water, and a CERCLA remedial action at a second former mine site where groundwater discharge is a major source of metals loading to the river adjacent to mine waste disposal facilities.

Years of Experience

39 – 5 years with Wood

Office of Employment

Sacramento/Idaho Falls

Languages

- English

Professional Associations

- Professional Engineer, CA, 80971
- Professional Engineer, GA, 14723
- Professional Engineer, ID, 13225
- Member, American Society of Civil Engineers
- Member, National Ground Water Association
- Member, Geological Society of America
- Member, American Geophysical Union

Areas of Expertise

- Characterization and remediation of contaminated groundwater, soil, and the vadose zone
- CERCLA remedial investigation / feasibility study and remedial design
- Hydrogeologic assessment and engineering design of groundwater extraction systems

Education

- PhD, Earth Sciences - Hydrogeology, University of Waterloo, 1988
- MS, Earth Sciences - Hydrogeology, University of Waterloo, 1984
- BS, Civil Engineering, Georgia Institute of Technology, 1978

Wood Experience

Bunker Hill Central Treatment Plant Upgrade and Groundwater Collection System, US Army Corps of Engineers – Seattle District, Kellogg, ID

Senior Hydrogeologist responsible for designing 19 extraction wells to intercept groundwater downgradient of mine waste disposal facilities to reduce metals loading to a river segment over one mile long, and a network of 43 observation wells to evaluate the effect of the extraction wells on the groundwater flow system in a surficial aquifer and a deeper confined aquifer. There are significant space constraints in the narrow available corridor between the disposal facilities and the river, exacerbated by the presence of underground utilities, a major highway, a historically-significant billboard, and that most of the corridor is within a floodway. Close coordination between various design teams was needed to locate the extraction and observation wells, conveyance pipelines, electrical and communication infrastructure, and a cutoff wall into the available space. This project is part of a remedial action at a CERCLA site.

Former Mine Site, Confidential Client, Eastern Sierra Nevada Mountains, CA

Senior Hydrogeologist responsible for planning and technical oversight of activities that reduced the risk of unplanned release of mining-influenced water, mine waste, and sediment. Impacted materials had accumulated along a creek downstream of a former mine. Mining-influenced surface water was impounded in a series of beaver ponds. Stakeholders were concerned that an unplanned release of impacted water, mine waste, and sediment if a beaver dam were to fail might affect downstream environmental conditions. The potential for an unplanned release was mitigated by reducing the volume of water impounded in the beaver complex. The beaver dams that formed the largest ponds were partially or completely removed. Gabion check dams were installed to control sediment erosion and transport. Field activities included initial and ongoing surveys for threatened/endangered species and cultural resources, water quality monitoring, constructing temporary access for heavy equipment in rugged terrain, installing a temporary pipeline and diverting streamflow around the work site, and restoring the site. Waste generated during dam removal and check dam construction was profiled and disposed in an off-site facility. Test plots were established in a drained beaver pond to evaluate the implementability and effectiveness of several erosion control measures for stabilizing sediments exposed after beaver ponds were drained. In addition to reducing the potential for an unplanned release, the study provided information about the cost, implementability, and effectiveness of remedial technologies that will be used to evaluate remedial alternatives in a CERCLA feasibility study.

Senior hydrogeologist responsible for planning and executing a focused remedial investigation to evaluate the vertical and horizontal extent, and the physical and chemical characteristics of mine waste in a creek downstream of a former mine. Waste transported from the mine and deposited downstream of the mine potentially contributes to acidification of surface water downstream of the mine. Characterization in this stream reach is complicated by steep terrain and dense vegetation that impede access, by the presence of an active beaver community that has constructed approximately 28 beaver dams, by the presence of historical artifacts adjacent to the creek, and by the potential presence of threatened or endangered species in the vicinity. Dr. Starr led development of the work plan, including incorporating input from federal and state environmental regulatory agencies, federal and state property administrators, the state wildlife agency, and a tribe. He oversaw implementation that included constructing access roads and a 2000 foot long water diversion, monitoring water quality, conducting geophysical surveys, and a drilling program for documenting lithology and providing samples for laboratory analysis. In a closely-related study, he developed and implemented plans for characterizing

mud incorporated into beaver dams to evaluate waste management requirements for debris if dams are removed.

Senior hydrogeologist responsible for developing a strategy to address geotechnical engineering tasks identified in an administrative order. Dr. Starr led the review of existing geotechnical information for the site, identified data gaps, and planned an approach for resolving data gaps using a combination of site characterization and evaluation of readily available information. He led planning and implementation of geotechnical characterization at a pond constructed on mine waste. The feasibility of using of this pond in the final remedy for the site, with or without modifying its configuration, is influenced by its geotechnical characteristics.

Senior hydrogeologist responsible for planning a field treatability study to evaluate the effectiveness of methods for establishing vegetation as part of a remedial alternative and the effect of revegetation on deep infiltration and groundwater recharge. Well established vegetation has the potential to substantially reduce the amount of water that moves deeper than the root zone, thereby reducing the amount of acid drainage generated in the disturbed portion of the site and that subsequently affects groundwater and surface water. Characterizing unsaturated flow properties and moisture movement in the shallow surface at barren and vegetated sites will provide a basis for predicting the effectiveness of revegetation as a component of a final remedy for the site.

Senior hydrogeologist responsible for scoping a feasibility study and supporting studies for a former open pit mine where acid drainage is generated from sulfide minerals in mine waste and in situ rock. A multi-faceted remedy will be required to address groundwater and surface water contamination, contaminated soil and sediment, and physical hazards at this remote site. Dr. Starr's familiarity with the CERCLA process, hydrogeology, geochemistry, and civil engineering resulted in a feasibility study program with sufficient scope to evaluate remedial alternatives that include a broad range of technologies.

Walker Mine Site, Confidential, Plumas County, CA

Technical Manager. Technical leader of a multidisciplinary team that examined historical documents and recent reports to develop an understanding of the environmental effects of mining and post-mining remedial efforts at a former copper mine. Acid drainage from the mine, which closed in 1941, degraded surface water downstream of the mine. Incomplete remedial actions by third parties reduced outflow from the mine portal but caused contaminated groundwater to discharge to previously unaffected streams in an adjacent watershed. Supported preparation of expert report and exhibits for an administrative hearing.

Other Experience

Remediation of Trichloroethene-Contaminated Groundwater at Atlas Missile Site 12, US Army Corps of Engineers, Omaha District, Windsor, CO

Senior hydrogeologist responsible for designing a pilot study of an innovative technology for remediating TCE-contaminated groundwater in a perched aquifer at a Formerly Used Defense Site where conventional approaches were limited by low conductivity, slow groundwater velocity, and thin saturated thickness. Our approach combined hydraulic fracturing technology developed to enhance hydrocarbon production with the use of long-lived granular remediation amendments. The resulting granular amendment filled fractures act both as preferential flow paths and in situ permeable reactive barriers, and promote both abiotic and biological degradation of dissolved TCE. The technology was deployed in a pilot test in the contaminant source area beside and beneath a building where historical release of TCE-contaminated wastewater resulted in mg/L range concentrations of dissolved TCE in groundwater. TCE concentrations

were reduced over 90 percent during the pilot test, and to less than the 5 µg/L drinking water limit at some locations. The successful pilot test led to an interim action in which the technology was applied throughout the core of the on-property plume. Dr. Starr wrote the decision document for full-scale remediation in which this technology will be deployed for the remainder of the on-property and off-property plume.

Remediation of Contaminated Groundwater at Idaho National Laboratory Test Area North, US Department of Energy, Idaho Falls, ID

Senior hydrogeologist responsible for evaluating technologies for remediating dissolved and DNAPL TCE in a deep, fractured rock aquifer where injection of industrial waste, sanitary waste, and radioactive waste resulted in a two mile long plume of contaminated groundwater. Evaluated grouted cutoff walls for isolating the contaminant source near the former injection well, in situ chemical oxidation for destroying TCE DNAPL and organic sludge with entrained and sorbed TCE, and zero valent iron for reducing dissolved TCE concentrations. Both in situ chemical oxidation and zero valent iron performed well in laboratory treatability studies. Dr. Starr then led a technical team that prepared an engineering design and technical work plans for conducting a field pilot test of in situ chemical oxidation.

Engineering Evaluation / Cost Analysis, and Soil Background Concentration Study for a Former Open Burn Site at Naval Air Station El Centro, Naval Facilities Engineering Command, El Centro, CA

Senior hydrogeologist responsible for planning and executing an engineering evaluation / cost analysis (EECA) to evaluate remedies for a non-time critical removal action to address contaminated soil and debris. Refuse from the installation was burned and the non-combustible residue, as well as unburned debris, were buried in an open dump. Soil and debris contaminated with metals, SVOCs, dioxins, and pesticides are present both on the installation property and on adjacent private land. Establishing remediation levels was complicated by naturally occurring concentrations of some inorganics that were above risk-based concentrations, and by organics derived from anthropogenic sources not related to the site. Dr. Starr planned and executed a study to determine the background concentrations in soil of metals, SVOCs, dioxins and furans, and pesticides. This study allowed achievable remediation levels for the removal action to be established.

Remediation of Lead-Contaminated Soil at an Open Burn / Open Detonation Site, US Army Corps of Engineers, Sacramento District, Tooele Army Depot, UT

Senior hydrogeologist responsible for identifying and developing a geochemical approach for stabilizing lead in contaminated soil. Off-spec and excess explosives and propellants were burned at the site, and the residue was buried in a shallow disposal trench. The buried waste and nearby soil had elevated concentrations of leachable lead. In a previous unsuccessful corrective action, the presence of large debris, metal banding, and wire rope interfered with mechanical mixing of granular stabilizing agents with the soil and debris. USACE commissioned a corrective measures evaluation to review a variety of remedial technologies for encapsulating or stabilizing the waste, and selected chemical stabilization for further evaluation. Conducted additional site characterization to refine the lateral and vertical extents of soil contamination and identify material with high lead concentrations for use in treatability studies. Designed and managed a laboratory bench study, in which a method was developed that reduced leachable lead determined via the Toxicity Characteristic Leaching Procedure by orders of magnitude and met Land Disposal Restriction limits. Designed and managed a field pilot test that demonstrated that the approach could be successfully used at the field scale.

White Sands Test Facility 300 Area and 600 Area Closure Investigations, National Aeronautics and Space Administration, Las Cruces, NM

Senior hydrogeologist responsible for interpreting characterization and monitoring data to assess the long-term performance of RCRA closures of former wastewater impoundments. Wastewater that contained dissolved solvents and nitrosamines was historically treated and disposed in unlined impoundments that were decommissioned and closed under RCRA approximately 25 years previously. During the operational phase of the impoundments, contaminants migrated through the vadose zone and contributed to a plume of contaminated groundwater that extends several miles downgradient. It was unclear if materials in the closed impoundments or in the underlying vadose zone were still acting as a source of groundwater contamination. Characterization and monitoring data for the closed impoundments, vadose zone, soil gas, and groundwater zone were evaluated and showed that neither the impoundments nor the vadose zone are currently contributing to the groundwater plume. Soil gas data were evaluated and showed that concentrations of volatile contaminants in soil gas are not high enough to adversely affect indoor air quality.

White Sands Test Facility Mid-Plume Constriction Area Pump and Treat System Infiltration Basins, National Aeronautics and Space Administration, Las Cruces, NM

Senior hydrogeologist responsible for characterizing hydrogeological and geochemical conditions in a thick vadose zone to select a location for infiltration basins used to recharge an aquifer with treated water from a groundwater treatment system. Selected potential sites for infiltration basins based on surficial sediment texture and infiltration rate. Evaluated the potential for mobilizing metals from the vadose zone to groundwater using leaching tests of core samples of vadose zone material. Conducted geochemical modeling using MINTEQ to predict the amount of mineral scale that would precipitate from treated groundwater discharged to the infiltration basin, which affects maintenance requirements for an infiltration basin. The infiltration basins were constructed and have been operated with no adverse effects.

Large Scale Infiltration Test, Idaho National Laboratory, U.S. Department of Energy, Idaho Falls, ID

Senior hydrogeologist responsible for designing, constructing, and operating a system for distributing radiotracer and chemical tracers throughout a 600-foot diameter pond that was the source term for an infiltration test and tracer study in a vadose zone that consisted of fractured basalt with fine-textured sedimentary interbeds. Senior scientist on site supervising measurement of water content and radiotracer profiles, and water samples from groundwater monitoring wells. The test provided field data for evaluating the validity of site conceptual models that were the basis of mathematical vadose zone flow and transport models used to predict the effect of hypothetical contaminant migration from an existing radioactive waste disposal facility into the underlying sole-source aquifer.

Modeling TCE Degradation with Competitive Inhibition Kinetics in Aerobic Groundwater, U.S. Department of Energy Environmental Management Science Program, Chicago, IL

Managed a research project that compared concentration profiles of TCE and conservative co-contaminants to determine that TCE degrades at environmentally significant rates in aerobic groundwater. The enzyme activity probe method demonstrated that cometabolic degradation was the responsible process. Supervised development of a module for RT3D software that incorporated cometabolic degradation kinetics. Conducted a sensitivity study to evaluate the effect of a reasonable range of kinetic parameter values on degradation rates, and supervised a groundwater transport modelling study that used the RT3D cometabolic degradation module to evaluate the effect of degradation under a range of conditions on contaminant plume evolution.

Effect of Development on Groundwater Quality, HDH Consultants, Idaho Falls, ID

Residential developments with on-site wastewater treatment may increase concentrations of nitrogen, phosphorus, and pathogens in groundwater. A highly permeable fluvial aquifer used a source of potable water in portions of southeastern Idaho is vulnerable to contamination. Supervised nutrient/pathogen evaluations of several proposed residential developments, including MODFLOW flow and transport modeling studies that were used to evaluate if the proposed number and size of houses could be constructed without causing unacceptable groundwater quality degradation. Worked closely with the design engineer to refine the proposed configuration at one development to minimize water quality impacts.

Modeling Pesticide Migration from Contaminated Soil to Groundwater at a Former Agricultural Chemical Facility, U.S. Environmental Protection Agency, Atlanta, GA

Developed site conceptual model for a facility where pesticide-contaminated soil remained at depth after an initial removal action, and simulated transport of pesticides through the vadose zone to predict concentrations in underlying groundwater. Evaluated the effectiveness of an existing pump and treat system for capturing contaminated groundwater.

Geochemical Modeling to Evaluate Mineral Scaling in Injection Wells and Infiltration Basins White Sands Test Facility Plume Front and Mid-Plume Constriction Area Pump and Treat Systems, National Aeronautics and Space Administration, Las Cruces, NM

Senior hydrogeologist responsible for evaluating the cause and potential remedies for precipitation of mineral scale in groundwater treatment system components, conveyance lines, and treated water injection wells that impaired system performance and increased maintenance requirements for a 1,000 gallon per minute groundwater pump and treat system. Used MINTEQ to evaluate the amount of mineral precipitation that would result from treating groundwater with high concentrations of calcium, dissolved carbon dioxide, and iron using air stripping. Air stripping caused elevated dissolved carbon dioxide concentrations to decline to the atmospheric-equilibrium concentration and resulted in carbonate mineral precipitation and scale formation. It also increased the concentration of dissolved oxygen, resulting in iron oxidation and precipitation. MINTEQ was also used to determine the amount of acid that would have to be added to prevent precipitation. A similar study was performed to evaluate how much mineral scale would accumulate in a proposed infiltration basin that was being considered as an alternative to injection wells for a second pump-and-treat system.

Geochemical Modeling Study to Evaluate Controls on Lead and Arsenic in Groundwater at Historical Phosphate Leaching Sites, U.S. Environmental Protection Agency, Atlanta, GA

Prior Firm Experience, $20K, 2004. Agricultural fertilizer was produced during the 19th century at several facilities in the coastal areas of North Carolina and South Carolina. Pyrite was roasted in lead-lined ovens to produce sulfuric acid for leaching phosphate from ore. Current conditions include groundwater with depressed pH and elevated concentrations of metals. A Geochemist's Workbench study was conducted to investigate the geochemical controls on lead leached from the oven liner, and on arsenic derived from arsenopyrite.

Waterloo Barrier Prototype Testing, Waterloo Centre for Groundwater Research, Waterloo, Ontario, Canada

Senior hydrogeologist responsible for planning and executing groundwater modeling studies to evaluate the use of cutoff walls for isolating groundwater contaminant sources and their effect on groundwater plumes, and to evaluate the effect of imperfections on overall barrier effectiveness. Designed, conducted,

and evaluated field tests of prototypes of the Waterloo Barrier (sheet piling with joints that are sealed after installation) to evaluate the effectiveness of sealing the joints between individual pieces of steel sheet piling to reduce leakage through a cutoff wall.

Funnel and Gate Modeling Study, Waterloo Centre for Groundwater Research, Waterloo, Ontario, Canada

Senior hydrogeologist responsible for planning and executing the first modeling study of the Funnel and Gate concept, which is a groundwater remediation system that uses low permeability cutoff walls to direct groundwater flow through high permeability reactive barriers.

Technical Support to U.S. Environmental Protection Agency CERCLA and RCRA Project Managers, Various EPA Regions, USA

Provided technical assistance to EPA project managers for 15 CERCLA and RCRA sites across much of the US. Performed independent review of characterization, pilot test, and remedy performance data, and review of work plans and reports submitted by presumed responsible parties or EPA contractors. Recommended characterization approaches for DNAPL sites, and for VOC-contaminated soil and groundwater. Conducted natural attenuation evaluations for petroleum, chlorinated solvents, and pesticides in groundwater. Evaluated pesticide migration from soil to groundwater. Evaluated the performance of Underground Injection Control wells used to dispose wastewater into a saline aquifer. Evaluated hydrogeologic characterization data related to expansion of an existing RCRA Subtitle C landfill. Provided technical support during EPA's interactions with PRPs and the public at a site where DNAPL disposal resulted in contamination of a municipal well field. Provided technical support to EPA during their interactions with a PRP group responsible for an operating chemical production facility where the subsurface is extensively contaminated with DNAPL and dissolved VOCs. Managed evaluation of the effects of in situ chemical oxidation on the groundwater microbial community, and the use of dissolved radon concentrations to assess the effectiveness of DNAPL remediation.

Expert Witness in Printcraft Press v. Sunnyside Utilities, Inc., and Sunnyside Industrial and Professional Park, LLC, Beard St. Clair Gaffney Attorneys, Idaho Falls, ID

Served as the primary expert witness in hydrogeology and civil engineering for litigation between a business located in an industrial park and the developer, which was related to failure of a wastewater treatment system. Based on our expert reports and pre-trial depositions, the opposing side capitulated on all technical aspects. The party represented by our client won the case and prevailed on appeal.

Professional History

- Wood Environment & Infrastructure Solutions, Inc., Senior Associate, Sacramento, California, 2017 to present
- Amec Foster Wheeler Environment & Infrastructure, Inc., Senior Associate - Hydrogeologist, Sacramento, California, 2013-2017
- North Wind Inc. and North Wind Services, Consulting Hydrogeologist, Idaho Falls, Idaho, 2003-2013
- Idaho National Engineering and Environmental Laboratory, various operating contractors, Senior Scientist and Advisory Scientist, Idaho Falls, Idaho, 1993-2002
- Waterloo Centre for Groundwater Research, Research Associate, Waterloo, Ontario, Canada, 1988-1993
- University of Waterloo Department of Earth Sciences, Graduate Research Assistant, Waterloo, Ontario, Canada, 1981-1988
- Law Engineering Testing Company, Water Resources Engineer, Marietta, Georgia, 1978-1981
- Georgia Department of Natural Resources, Environmental Technician, Atlanta, Georgia, 1975-1977.

Blake J. Easby, PE
Sr. Geotechnical Engineer – Rock Mechanics

Summary

Years of Experience

10+

Office of Employment

Reno, NV

Education

M.S., Geological Engineering
University of Idaho
Moscow, ID
2018

Applied Geotechnics Graduate Certificate
University of Idaho
Moscow, ID
2015

B.S. Geological Engineering
University of Nevada
Reno, NV
2010

Registrations / Certifications / Licenses)

Professional Engineer Nevada (Civil), No. 023393

Additional Training

Mine Safety and Health Administration (MSHA) 24-hour surface miner training – Current

HAZWOPER 40-hour — Current

OSHA 10-hour Construction

Professional Affiliations

Member, Society for Mining, Metallurgy, and Exploration (SME)

Professional Summary

Mr. Easby has over ten years of experience practicing in geotechnical engineering with a specialty in open pit rock mechanics and pit slope design. His experience includes geotechnical field investigations, rock mass and soil characterization, and slope stability analysis. He has been involved in the design, operation, monitoring, and management of large open pit slopes and has completed design studies from scoping-level to feasibility and optimization. He has performed investigations of many pit slope instabilities and provided pit slope failure mitigation strategies and design recommendations. His experience includes projects located in the USA, Canada, Mexico, Central America, and Turkey.

Recent Project Experience

Senior Engineer

Dundee Precious Metals, Timok, Republic of Serbia

Senior Engineer providing oversight and support for Feasibility level pit slope design study consisting of three mineralized zones and six open pits. Provided oversight and support for geotechnical model development and characterization, and overall slope stability analyses. Performed kinematic analysis and developed open pit slope design recommendations with an emphasis on structural controls and blasting implementation.

Senior Engineer

Confidential Client, Tucson, AZ

Technical lead for Prefeasibility level pit slope design study for six open pits at copper mine. Supervised field investigation which included geotechnical core logging, mapping, and rock mechanics laboratory testing. Developed geotechnical models of the rock mass, performed structural characterization, kinematic analysis, and limit equilibrium stability analyses of the rock slopes for isotropic and anisotropic conditions. Provided pit slope design recommendations and prepared Prefeasibility level report.

Senior Engineer

SCC, El Arco, Baja California, Mexico

Performed stability analyses and provided scoping level pit slope design recommendations based on available data.

Recent Project Experience (continued)

Senior Engineer

Wilson &Co., Blue Canyon Rockfall Evaluation, AZ

Performed rock fall analysis, evaluation of rock fall mitigation options, and rock cut slope designs for a proposed road improvement project in Fort Defiance, AZ. Worked with the public and members of the tribe to evaluate mitigation options.

Senior Engineer

Kinross, Fort Knox, Alaska

Senior Engineer providing oversight and support for ongoing pit slope geotechnical work at Fort Knox Gold Mine. Provided oversight and developed laboratory testing programs, geotechnical characterization updates, kinematic structural analysis, and slope stability analyses (Slide2™ 2D Limit Equilibrium and FLAC3D™).

Senior Engineer

Rawhide Mining Co., Rawhide Mine, NV

Performed pit slope geotechnical review of the Regent open pit. Provided recommendations for geotechnical data collection and pit slope design optimization program.

Senior Engineer

OMYA, White Knob Quarry, CA

Performed field reconnaissance and provided investigation and design support for a pit slope instability in a limestone quarry. Performed back analysis and evaluation of a structurally controlled slope deformations along a weak fault, provided recommendations for temporary remediation and additional investigation and analyses.

Senior Engineer

US Silica, Clark Operations, NV

Performed field reconnaissance of a recent slope instability in a Diatomite quarry. Provided mining recommendations to reduce the risk of further slope instability for short range mine planning and provided recommendations for additional investigation and analyses to support future mine design and operations, and to support geotechnical design for SK-1300 reporting.

Senior Engineer

Liberty Gold, Black Pine, ID

Lead engineer for scoping level pit slope design investigation and study. Performed site reconnaissance, geologic model review and geotechnical model development, and performed slope stability analyses to support scoping level pit slope design recommendations. Provided recommendations for Prefeasibility level pit slope design geotechnical investigation.

Lead Engineer

Nevada Gold Mines, Long Canyon, NV

Technical lead for feasibility level pit slope design study for Phase 2 expansion of the Long Canyon pit. The expansion exposes alluvium slopes of up to about 300 feet high. The study included drilling of five geotechnical coreholes, laboratory testing and geotechnical characterization. Provided pit slope design recommendations considering different dewatering scenarios and opportunities for slope steepening and bench configuration optimization.

Technical lead for evaluation of Cut 10 pit "footwall" slope design along persistent bedding joints. Provided design recommendations that addressed the risk of planar failure along bedding joints and provided opportunities for optimization where the "footwall" slope design was not required

Project Engineer

Kinross, Round Mountain Mine, NV

Provided project support for Round Mountain mine for over five years including an on-site assignment to assist the technical services department with slope monitoring, documentation of geotechnical hazards, and operational support. Responsible for several geotechnical studies including the Phase J instability, East Phase F instability, Phase W feasibility study, Southwest alluvium instability, Phase S feasibility study. Provided supervision for geotechnical core drilling programs including rock and soil core logging, QAQC procedures, and sample selection. Performed interpretation of slope monitoring data (radar, prism, InSAR), 2D and 3D LE and 2D FE back-analyses of various failure episodes, geotechnical model development and structural characterization, interpretation of laboratory testing and numerical modeling (FLAC™, FLAC3D™, RS2™).

On-site secondment assignment providing slope monitoring support, documentation of geotechnical hazards, and geotechnical guidance to operations. Performed interpretation of slope monitoring data (two Reutech MSR and one IBIS-FM radar systems, two robotic total stations and prisms, InSAR) and analyzed VW piezometer, TDR, and inclinometer data during periods of active slope instability. Performed geotechnical inspections, prepared daily and weekly reports for mine management, and participated in daily line-out meetings. Performed failure runout analyses (DAN3D) to define exclusion zones and safe operating areas. Updated Ground Control Management Plan (GCMP) and Trigger Action Response Plans (TARP)

Lead Engineer

Elko Mining Group, Ruby Hill Mine, NV

Performed review of slope monitoring data including prisms and inclinometers and provided recommendations for slope monitoring for reentry to East Archimedes pit including recommendations for the TARP and GCMP. Performed monthly monitoring data reviews (IBIS ARCSAR radar, prism network, and inclinometers) during operations and provided monitoring recommendations.

Evaluated re-entry into the Ruby Hill pit following a pit slope failure to mine below the failed slope and slide debris. Reviewed slope monitoring data including prisms and inclinometers. Performed rockfall analyses using CRSP to assess the risk of blocks of cemented alluvium or boulders falling from the failure scarp of reaching the working area. Performed 2D LE stability analysis to provide slope design recommendations in the failure debris. Provided rockfall protection recommendations and design recommendations for mining in and below the failure debris. Performed limit equilibrium slope stability analyses of an expansion of the East Archimedes pit.

Project Engineer
Barrick, Cortez, NV

Provided project support for feasibility-level pit slope design study for expansion of the Pipeline pit. Responsible for two-dimensional (2D) analysis of the stability of the expansion in two phases. Performed kinematic analysis which formed the basis for bench and inter-ramp slope design. Provided pit slope design recommendations and prepared feasibility-level pit slope design report.

Provided project support for the Crossroads Feasibility-level pit slope study which involves slopes in alluvium of up to 1000 ft overlying bedded limestone. Supervised feasibility-level geotechnical drilling program with a focus on collecting intact samples of valley fill alluvium. Assisted with testing program to collect shear strength and deformability properties for use in evaluating potential for ground subsidence due to dewatering, and to characterize alluvium and rock units for stability analyses. Developed geotechnical models of the alluvium and rock mass, performed structural characterization, kinematic analysis, and performed 2D LE stability analyses of the alluvium and the rock slopes for isotropic and anisotropic conditions. Provided pit slope design recommendations and prepared Feasibility-level report.

Project Engineer
Santa Elena Mine, Sonora, Mexico

Performed geotechnical data analysis to support rock mass characterization and geotechnical model for an underground silver mine; created cross sections and developed preliminary geotechnical domains to determine ground support sectors. Provided scoping level recommendations for ground support.

Project Engineer
Escobal Mine, Guatemala

Prepared a series of figures and cross-sections showing geotechnical drill core data for underground silver mine to support long hole stoping design review and ground support recommendations. Developed preliminary geotechnical domains and recommendations for ground support.

Project Engineer
Mercedes Mine, Sonora, Mexico

Analyzed and plotted geotechnical data in a series of figures and cross-sections for an underground gold-silver mine to support rock mass characterization and development of a geotechnical model; performed long hole stoping design review and provided ground support recommendations.

Project Engineer
Cerro Quema Mine, Los Santos, Panama

Completed pre-feasibility level pit slope design study that included: a preliminary scoping review of existing data in support of open pit mine plan; site visit and geotechnical investigation that included surface mapping, review of exploration drill core and geotechnical logging, review and interpretation of current geological model; limit-equilibrium slope stability analyses, and development of pit slope design recommendations.

Completed a geotechnical investigation for waste rock disposal facilities and heap leach facilities that included soil logging and sampling 20 test pits excavated by track excavator and by hand crews where access by the excavator was not possible; completed geotechnical investigation engineering report.

Project Engineer
Bingham Canyon, Utah, USA

Performed rock mass structural analysis and developed structural domains for slope stability analysis of southeast sector of open pit adjacent to recent Manefay pit slope failure. Performed pit slope stability analysis and unloading options. Created cross-sections of geologic and hydrogeologic data to support geotechnical model. Completed preliminary geotechnical characterization report.

Professional History

- Wood E&IS (Aug. 2021 – Present)

  Sen*ior Geotechnical Engineer*
- Golder Associates Inc. (Jan. 2011 – Aug. 2021)

  Staff to Senior Geological Engineer

Veerakcuddy Rajasekaram, Ph.D., P.Eng.
Senior Water Resources Engineer

Summary

Years of Experience

Over 21 Years of Canadian professional experience; 1 year with Wood

Office of Employment

Calgary, Alberta

Languages

English

Professional Associations

Member, Association of Professional Engineers and Geoscientists of Alberta (APEGA)

Areas of Expertise

- Stormwater and Irrigation Systems Modeling
- Hydrologic Analysis and Distributed Hydrologic Modeling
- Computational Fluid Dynamics/ Hydraulic and Water Quality Modeling River Engineering, and Flooding Analysis
- Water Resources, Mine - Site and Environmental System Modeling

Professional Summary

Dr. Rajasekaram is an experienced water resources engineer with key strengths including stormwater modeling and management, river engineering, flooding analysis, hydraulic/ hydrologic modeling, water quality modeling, and system dynamics. He has over 21 years of professional engineering experience in:

- Mathematical and computational fluid dynamics modeling of various water resources systems using the state-of-the-art software and modeling tools
- Project and Team Management
- Client Relationship
- Mentoring of Junior Staff
- Technical Review of Projects
- Project Reporting/ Proposal Writing

Qualifications

Education

- Ph.D. (Doctor of Engineering, Water Resources Engineering), Asian Institute of Technology, Thailand, 1997
- M.Eng. (Water Resources Engineering), Asian Institute of Technology, Thailand, 1993
- B.Sc. (Civil Engineering) Hons, University of Peradeniya, Sri Lanka, 1981

Skills

- Sound knowledge of various engineering and modeling software: PCSWMM, XPSWMM, SWAT, QSWAT, HSPF, MIKE11, MIKE21, MIKE-SHE, HEC-RAS, HEC-HMS, EFDC, CE-QUAL-W2, SMS/RMA, CCHE2D, GoldSim, ArcGIS, QGIS
- Experienced in design of hydraulic structures and various data analysis techniques
- Software and macro authoring using Visual Studio software development tools, Excel VBA and Python

Publications / Presentations

- V. Rajasekaram, G.A. McBean and S.P. Simonovic. 2010. A Systems Dynamic Modeling Approach to Assessing Elements of a Weather Forecasting System. Atmosphere-Ocean, Canadian Meteorological and Oceanographical Society, 48(1), 1 – 9.

Publications / Presentations (con't)

- McBean, G.A., V. Rajasekaram and S.P. Simonovic. 2007. A Systems Dynamic Modeling Approach to Assessing Elements of a Weather Forecasting System. CMOS-CGU-AMS Congress 2007, Canadian Meteorological and Oceanographical Society. St. John's, NL, Canada. May 28 – Jun. 1.
- Rajasekaram, V. and K.D.W., Nandalal. 2005. Decision Support System for Reservoir Water Management Conflict Resolution. Journal of Water Resources Planning and Management. ASCE, 131(6), 410-419.
- Rajasekaram, V. and S.P. Simonovic. 2005. Impact of Regional Water Quality on Canadian Development Sectors, 17th Canadian Hydrotechnical Conference of the CSCE. Edmonton, Alberta, Aug. 17–19.
- Rajasekaram, V. 2005. Application of Spatial System Dynamics for Watershed Modelling, International Conference on Hydrological Perspectives for Sustainable Development (HYPESD-2005). Roorkee, INDIA, Feb. 23-25.
- Rajasekaram, V. and K.D.W. Nandalal. 2004. System Dynamics-Based Decision Model for Water Management in Walawe Basin, Sri Lanka, International Conference on Sustainable Water Resources Management in the Changing Environment of the Monsoon Region. Colombo, Sri Lanka, Nov. 17-19.
- Simonovic, S.P. and V. Rajasekaram. 2004. Integrated Analyses of Canada's Water Resources: A System Dynamics Approach, Canadian Water Resources Journal. 29(4), 223-250.
- Rajasekaram, V. and K.D.W. Nandalal. 2003. Distributed Watershed Modelling using Object Oriented Programming, 16th Canadian Hydrotechnical Conference of the CSCE. Oct. 21-24.
- Simonovic, S.P. and V. Rajasekaram. 2003. A Model for Assessment of Canadian Water Resources through System Dynamics Simulation, 16th Canadian Hydrotechnical Conference of the CSCE. Oct. 21-24.
- Rajasekaram, V., S.P. Simonovic and K.D.W. Nandalal. 2003. Computer Support for Implementation of a Systematic Approach to Water Conflict Resolution, Water International. 28(4), 454-466.
- Rajasekaram, V., K.D.W., Nandalal and S.P. Simonovic. 2002. A Conflict Resolution Support System for Use in Water Resources Management, International Conference: 'From Conflict to Co- operation in IWRM'. Delft, The Netherlands, Nov. 20-22.
- Patrapanich, M., V. Rajasekaram, and M.A. Habib. 2000. Applications of Hydrodynamic Modelling. National Workshop on Data and Model Inventory organized by Mekong River Commission. Nakorn Ratchasima, Thailand, Aug. 31 – Sep. 1.
- Tingsanchali, T. and V. Rajasekaram. 1997. Reliability-based Optimal Reservoir Operation of the Mae Klong River Basin, 9th World Water Congress, IWRA. Montreal, Canada, Sept. 1-6.
- Tingsanchali, T. and V. Rajasekaram. 1997. Water Resource System Operation Under Hydrologic Uncertainty: the Mae Klong River Basin, Thailand, 27th IAHR Congress. San Francisco, USA, Aug. 10-15.
- Tingsanchali, T. and V. Rajasekaram. 1996. An analytical Model for Flow Routing in Urban Channel Networks, International Conference on Urban Engineering in Asian Cities in the 21st Century. Bangkok, Thailand, Nov. 20-23.

- Tingsanchali, T. and V. Rajasekaram. 1994. Application of HEC-3 Model to Assess Water Resources Availability of the Mae Klong River Basin, Thailand, International Agricultural Engineering Conference. AIT, Thailand, Dec. 6-9.

Experience

River Engineering and Flood Management Modeling Projects

- Technical Lead, Battle River Hydraulic Analysis and Water Quality Modeling, Alberta Environment and Parks, AB, 2018 - 2020
- Lead Hydraulic Modeler, Hydrodynamic, Sediment Transport and Gravel Nourishment Analysis and Modeling of Elbow River Below Glenmore Dam, Alberta Environment and Parks, AB, 2016
- Lead Hydraulic Modeler, Hydrodynamic and Morphological Assessment of Pipe Crossing Across the Bow River Near Douglas Dale, City of Calgary, AB, 2016
- Technical Reviewer, Hydraulic Assessment of Pipe Crossing at Bull Creek, Repsol Oil and Gas, AB, 2016
- Hydraulic Modeler, Bank Stability Analysis of Elbow River Near Discovery Ridge, City of Calgary, AB, 2015
- Hydraulic Modeler, Bank Stability Analysis of Bow River Near Glenmore, City of Calgary, AB, 2014
- Hydraulic Modeler, Bank Stability Analysis of Bow River Near Calf Robe, City of Calgary, AB, 2014
- Project Engineer, Flooding Assessment of Fish Creek near Priddis, Ghostpine Environmental Services, AB, 2014
- Project Engineer, Flooding Analysis of Red Deer River and Clearwater River, AltaLink Management Ltd., AB, 2014
- Hydraulic Modeling Lead, Hydraulic Analysis and Water Quality Modeling of Highwood River, Alberta Environment and Parks, AB, 2013 – 2014
- Technical Lead, Kananaskis River Bank Protection Analysis and Hydraulic/Morphological Modeling, AltaLink Management Ltd., AB, 2014
- Project Engineer, Flooding Assessment of Elbow River at Rideau- Roxboro, City of Calgary, AB, 2013
- Project Engineer, Flood Hazard Identification of Bow River Below Ghost Dam, Alberta Environment and Parks, AB, 2012
- Project Engineer, James River Flooding Analysis and Hydraulic Modeling, Private Client, Red Deer, AB, 2011
- Hydraulic Modeler, Athabasca River Hydraulic Analysis and Modeling Near White Court, Swan Hills Synfuels, AB, 2011
- Project Engineer, Lott Creek Flooding Analysis and Flood Risk Mapping, Rocky View County, AB, 2011
- Project Engineer, Evaluation of the Impact of Probable Maximum Flood in Bow River, TransAlta Energy Corp., AB, 2009
- Hydraulic Modeler, Hydraulic Analysis and Modeling of River Water Intake Structure for Kearl Mine, Imperial Oil Canada Ltd., Fort McMurray, AB, 2008

- Hydraulic Modeler, Hydraulic Analysis and Modeling of Pump Intake, Shell – Albian Oil Sands Project, Fort McMurray, AB, 2006
- Hydraulic Modeler, Dam-breach/ Floodplain Modeling and Analysis of Pantabangan and Masiway Dams, National Irrigation Administration, the Philippines, 1996

Stormwater Modeling and Management Projects

- Hydraulic Modeler, Stormwater modeling of the Heritage Road Layover Facility, Metrolinx, ON, 2022 – ongoing
- Hydraulic Modeler, Stormwater modeling support and review of West Calgary Ring Road and area, City of Calgary, AB, 2021 – 2022
- Technical Reviewer, Water Balance Modeling of Shepard Waste Management Facility, City of Calgary, AB, 2017
- Technical Reviewer, Stormwater and Irrigation Management Various Industrial Lots in Rocky View County, Various Clients, AB, 2014 – 2017
- Project Engineer, Operation Optimization Modeling of Storm Ponds near 84th Street, Rocky View County, AB, 2011
- Developer, Development of Stormwater Balance Spreadsheet (WBSCC), City of Calgary, AB, 2011
- Project Engineer, Watershed Operation Modeling for Vermilion River Basin, North Saskatchewan Watershed Alliance (NSWA), AB, 2009
- Project Engineer, Data Analysis Support for Alberta Water Supply- Demand Assessment, Alberta Environment, AB, 2008
- Stormwater System Modeler, Stormwater Management Modeling of Gardner Stormwater System, Western Securities Ltd., AB, 2007

Hydrologic and Water Quality Modeling Projects

- Lead Water Quality Modeler, Estimation of Acceptable Loading Limits to WH Canal and Chestermere Lake, City of Calgary, AB, 2018 - 2020
- Lead Modeler, Battle River basin Hydrologic Analysis, Hydraulic and Water Quality Modeling, Alberta Environment and Parks, AB, 2018 – 2020
- Water Quality/ Dispersion Modeler, Water Quality-based Effluent Limits Analysis for Bow River Near Outfall B5, Enmax Corp., AB, 2019
- Dispersion Modeler, Water Quality-based Effluent Limits Analysis for Rosebud River, Symbiotic EnviroTek Inc., AB, 2018
- Lead Water Quality Modeler, Water Quality Modeling of Weed Lake, Rocky View County, AB, 2017
- Lead Hydraulic Modeler, Cooling Water Effluent Heat Dispersion Modeling, AB Mauri Canada Ltd., AB, 2016
- Lead Modeler, Water Quality Modeling of the Plant Wastewater Disposal, Swan Hills Synfuels, AB, 2012

- Hydrologic Modeler, Mine Site Water Balance Modeling of Milner #14 Coal Mine, Maxim Power Corp., Grand Cache, AB, 2011
- Hydraulic Modeler, Tailings Pond Temperature and Sediment Dispersion Modeling, Total E&P Canada Ltd., Fort McMurray, AB, 2009
- Hydraulic Modeler, Thermal Plant Outfall Temperature Dispersion Modeling, Minneria Petaquilla S.A., Panama, 2009
- Hydrologic Modeler, Joslyn North Mine Site Stormwater Balance Modeling, Total E&P Canada Ltd., Fort McMurray, AB, 2009
- Project Engineer, Athabasca River Water Allocation Modeling for Oil Sands Mine Operators, Alberta Oil-Sands Developers Group (OSDG), AB, 2007 - 2009
- System Modeler, Beaver Creek Diversion System Operation Modeling, Syncrude Canada Ltd., Fort McMurray, AB, 2009
- Hydrologic Modeler, Distributed Hydrologic Modeling of Reclaimed Area, Total E&P Canada Ltd., Fort McMurray, AB, 2008
- Project Engineer, Review of Hydrometric and Climate Data for Syncrude Monitoring Stations, Syncrude Canada Ltd., Fort McMurray, AB, 2008
- Project Engineer, Hydrologic Modeling Support for the Design of Compensation Lake and Drainage Channels, Total E&P Canada Ltd., Fort McMurray, AB, 2008
- Project Engineer, Hydrologic Modeling Support for the Pierre River Mine Development, Shell Canada Ltd., Fort McMurray, AB, 2007
- Water Quality Modeler, Mine Site Water Quantity and Quality Management Modeling for Alto-Chicama Mine, Minera Barrick Misquichilca S.A., Peru, 2007
- Project Engineer, Runoff Estimation of Reclaimed Areas, Syncrude Canada Ltd., Fort McMurray, AB, 2007

Research and Innovation Projects

- Project Manager, Climate Prediction Scenarios and River Water Quality Models for Battle River Basin, Alberta Environment and Parks, AB, 2017
- Researcher/Software Developer, Water Resources System Management Software Development, University of Western Ontario, London, ON, 2006
- Researcher/Dynamic System Modeler, Dynamic Modeling of Canadian Weather and Environmental Prediction System, CFCAS, University of Western Ontario, London, ON, 2005
- Researcher/Dynamic System Modeler, Integrated Water Resources Assessment Modeling for Canada, NSERC, University of Western Ontario, London, ON, 2003 - 2004

TECHNICAL TRAINING

- Stochastic System Dynamics and Contaminant Transport Modeling using GoldSim, GoldSim Technology Group, Issaquah, WA; 2007
- Groundwater and Surface Water Integrated System Modeling using MIKE-SHE, Danish Hydraulic Institute, Portland, OR; 2007
- 3-D Hydrodynamic Modeling using ANSYS CFX, ANSYS Inc., Waterloo, ON; 2006
- System Dynamics Modeling using STELLA, University of Western Ontario, London, ON; 2002
- Coastal and Estuarine Modeling using MIKE-21 (by DHI staff), Asian Institute of Technology, Thailand; 1998
- Object-oriented and Database Programming using Microsoft Visual Studio, ACECOM, Asian Institute of Technology, Thailand; 1995
- Geographic Information System Development using ArcInfo, Asian Institute of Technology, Thailand; 1995
- Surface Water System Modeling using MIKE11 and NAM (by DHI staff), Asian Institute of Technology, Thailand; 1993
- Hydro-meteorological Measurements and Data Analysis Techniques, Asian Institute of Technology, Thailand; 1991

Professional History

- Wood, Water Resources Engineer, Senior Modeler, Calgary, AB (2021 – Present)
- Westhoff Engineering Resources Inc., Water Resources Engineer/ Senior Modeler, Calgary, AB (2011 – 2021)
- Golder Associates Ltd., Water Resources Engineer/ Senior Modeler, Calgary, AB (2006 – 2010)
- University of Western Ontario, Post-doctoral Researcher, London, ON (2001 – 2005)
- Southeast Asia Technology Co. Ltd., Senior Water Resources Engineer, Bangkok, Thailand (1997 – 2001)
- Asian Institute of Technology Post-graduate Student/ Researcher, Bangkok, Thailand (1992 – 1997)
- Irrigation Dept., Irrigation Engineer, Sri Lanka (1982 – 1991)
- University of Peradeniya, Assistant Lecturer, Sri Lanka (1982)

Greg Gosson, P.Geo.
Technical Director, Geology and Compliance

Summary

Years of Experience

41

Industries

- Mining & minerals

Areas of Expertise

- Securities regulatory compliance
- NI 43-101 Technical Reports
- Economic geology, mining studies, mineral resource audits

Qualifications

Education

Ph.D., Geology, Victoria University of Wellington, New Zealand, 1986

B.Sc. (Honours), Geological Sciences, Queen's University, ON, Canada, 1979

Courses in various mineral deposits, gold sampling, diamond exploration/ sampling/evaluation, exploration geophysics and other subjects

Registrations / Certifications

Professional Geoscientist in BC, Canada

Professional Geoscientist in Ontario, Canada

Publications / Presentations

Numerous presentations and articles on mining disclosure requirements subject to Canadian securities regulations

Languages

English

Experience

Technical Director, Geology and Compliance (2006-date), responsible for functional oversight of all geologists in Mining & Minerals' consulting offices. Provides senior-level reviews of geology and securities regulatory compliance on many of Wood's studies; delivers short courses on Canadian and US mining disclosure standards; and conducts workshops on mineral resource and mineral reserve estimation practices. Projects have included:

- Compliance reviews of NI 43-101 Technical Reports, Numerous Clients, 2016-date: These include:
  - Santa Rita, Atlantic Nickel, Brazil, 2020: Preliminary Economic Assessment (PEA) of developing the underground after the open pit is exhausted at a nickel-copper-cobalt mine
  - Cozamin and Santo Domingo, Capstone, Mexico and Chile, 2020: Feasibility studies of a copper-silver and a copper-iron project
  - KSM, Seabridge Gold, BC, Canada, 2020: PEA update and prefeasibility study of a copper-gold project
  - Patterson Lake South, Fission Uranium, SK, Canada, 2019: PEA of a uranium project
  - Newmont, 2019: Material mining operations in North and South America, Australia and Africa
  - Antakori, Regulus Resources, Peru, 2019: Mineral resource update of a gold-silver-copper project
  - Gibellini, Prophecy Development, NV, USA, 2018: PEA of a vanadium project
  - Oyu Tolgoi JV, Entrée Resources, Mongolia, 2018: Copper-gold venture properties and operations

  - Côté Gold, IAMGOLD, ON, Canada, 2016-2018: PEA, prefeasibility and feasibility studies of an open-pit gold mine
  - Idaho-Maryland, Rise Gold, CA, USA, 2017: Exploration potential of a gold property
  - Cerro Lindo, Vazante, and Morro Agudo, Nexa Resources, Peru and Brazil, 2017: Three copper-zinc mining operations, with updated mineral resource and reserve estimates
  - Guanaco, Argentex Mining, Chile, 2016: Gold mining operations and resource estimates
  - El Alacran, Cordoba Minerals, Colombia, 2016: Copper-gold-silver mineral resource estimate
  - Goldcorp, 2015-2016: Material mining operations in North and South America.
- Carlin, First Vanadium, NV, USA, 2020: NI 43-101 compliance review and co-author of a Technical Report on the PEA of a vanadium project.
- Cuajone, Toquepala and Tia Maria, Southern Copper, Peru, 2020: S-K 1300 gap analysis for preparation of Technical Report Summaries (TRSs) of two operating copper mines and the feasibility study of a third.
- Donlin Gold, NOVAGOLD, AK, USA, 2020: Review of NI 43-101 Technical Report and gap analysis for S-K 1300 TRS of a feasibility study update of a large open-pit gold project.
- Yatela, AngloGold Ashanti, Mali, 2016: Senior review of assessment of remaining mineral resources and exploration potential at a gold mine.
- Obuasi, AngloGold Ashanti, Ghana, 2016: Senior review of mineral resource estimates in support of the feasibility study of expanding a gold mine.
- Red Dog, Teck, AK, USA, 2015: Resource and reserve audit, in accordance with the COSO framework, of a large open-pit lead-zinc project.
- Galore Creek, NovaGold, BC, Canada, 2013: Senior review of a third-party prefeasibility study of a large open-pit porphyry copper-gold-silver project.
- Accha, Zincore Metals, Peru, 2013: Senior review of the prefeasibility study of adding a pyrometallurgical plant and hydrometallurgical refinery, with associated mining, infrastructure and ancillary improvements, at an operating zinc-lead mine.
- Black Butte, Tintina Resources, MT, USA, 2013: Senior review of the scoping study of the Lowry and Johnny Lee zones at an underground copper-cobalt-silver longhole stoping/overhand cut & fill mine.
- Greens Creek, Hecla Mining, AK, USA, 2013: Senior review of a resource and reserve audit of four key deposits at an operating underground gold-silver-lead-zinc mine, and of the subsequent NI 43-101 Technical Report.
- Kalukundi, Africo Resources, Congo, 2013: Post-feasibility study resource estimate update for a copper-cobalt mine under development.
- Duck Pond, Teck, NL, Canada, 2012-2013: Senior review for the update of a mineral resources and mineral reserves statement at an operating massive sulphide copper-zinc mine.
- Kitsault, Avanti Mining, BC, Canada, 2010, 2013: Senior review of the prefeasibility study, feasibility study, and feasibility study update of restarting a closed porphyry molybdenum-lead-silver project.

- Oyu Tolgoi, Oyu Tolgoi LLC, Mongolia, 2012: Senior review of the resource estimate of a large open-pit and underground copper-gold mine under development.
- Constancia, Hudbay Minerals, Peru, 2012: Senior review of a mine planning report for an open-pit copper-molybdenum property.
- Nokomis, Duluth Metals, MN, USA, 2012: Resource estimate review for an underground PGM-copper-nickel-cobalt deposit.
- Bisha, Nevsun Resources, Eritrea, 2011-2012: Assistance in the feasibility study of a gold-silver-copper-lead-zinc VMS project and mine operating cost estimate, as well as a senior review of a resource estimate update.
- Mazenod, BFR Copper & Gold, NT, Canada, 2011: Senior review of an NI 43-101 Technical Report on the geology of an open-pit/underground iron-oxide copper-gold (IOCG) deposit based on data held in Phelps Dodge's archives.
- Gibellini, American Vanadium, NV, USA, 2011: Feasibility-level risk assessment of a 3M tpy vanadium heap leach project.
- Newmont, Worldwide, 2009: Review of the corporation's Mineral Resource and Mineral Reserve audit system, including recommendations for an improved process and governance framework.
- Aksu-Diamas, AMR, Turkey, 2011: Senior review of the mineral resource estimate of a rare-earths project.
- Galore Creek, GCMC, BC, Canada, 2010-2011: Preparation of a new NI 43-101 Technical Report summarizing the third-party prefeasibility study of a large open-pit porphyry copper-gold-silver project.
- Santa Ana, Hecla Mining, Peru, 2010: Senior review of Wood's due diligence of an open-pit silver property at the feasibility stage of development.
- Cerro Negro, International Copper, Chile, 2010: Senior review of a Competent Person's Report on a porphyry copper-silver-gold project.
- Copperwood, Orvana Minerals, MI, USA, 2010: Senior review of a resource estimate and NI 43-101 Technical Report on an underground sediment-hosted copper project.
- Red Dog, Teck Cominco Alaska, AK, USA, 2006-2007: Independent review and preparation of an NI 43-101 Technical Report (updating Wood's earlier report) on an operating lead-zinc mine and mill.

BC Securities Commission, 2002-2006

Chief Mining Advisor for the British Columbia Securities Commission, the principal securities regulator for over half the world's public mining companies. Major accomplishments:

- Led the Canadian Securities Administrators' project to revise NI 43-101 rules in 2005.
- Helped draft new civil liability legislation and rules for continuous disclosure obligations that are now in effect across Canada.
- Responsible for securities regulators' acceptance of important carve-outs for the mining industry under NI 51-101, "Continuous Disclosure Obligations".

- Led initiatives to educate the mining industry on NI 43-101 and other mining disclosure requirements under North American securities regulations.

Also provided technical advice to commission staff; reviewed prospectuses and continuous disclosure filings, compliance cases, take-over bid issues relating to mining companies and mining industry education projects; reviewed legislation, policies and guidelines for the mining and oil & gas industry; co-chaired the Canadian Securities Administrators Mining Technical Advisory and Monitoring Committee on NI 43-101; and served on the Canadian Securities Administrators-CIM Committee on Mineral Resources and Mineral Reserves.

Casmyn, 1991-2001

- Managing Director, Casmyn Mining (1994-2001). Developed and managed exploration projects involving gold and kimberlite hosted diamonds in South Africa, greenstone gold in Zimbabwe, and Copperbelt-type copper-cobalt in Zambia. Opened exploration offices in South Africa and Zimbabwe. Responsible for acquisition and prefeasibility/feasibility studies of three gold properties in Zimbabwe. Supervised a US$5M exploration program and US$25M of mine development projects in Zimbabwe, with more than 450 full-time employees and 100 contract employees.
- Chief Geologist, Casmyn USA (1991-1994). Contracted to junior public companies to manage gold and copper exploration projects in the western US and Netherlands Antilles, and diamond exploration projects in South Africa. Work included field evaluations, negotiation of property agreements, budgeting, hiring staff and establishing field offices.

Total Energold, 1987-1991

Managed exploration projects for subsidiaries including Plexus Resources and Sovereign Exploration in the USA, and for the Mt. Skukum gold mine in YT, Canada. Evaluated mineral property submittals and developed strategies, plans, and budgets for exploration efforts. Supervised multi-million dollar exploration projects in NV, UT, ID, AZ and OR, USA. Participated in the feasibility study of a copper breccia pipe in Oregon. Constructed geological models for mineral resource estimation. Provided technical oversight to the non-operating JV partner (Plexus) of the Rawhide gold mine in NV.

BP Minerals, 1980-1986 (part-time)

Helicopter reconnaissance stream sediment, and detailed lithogeochem surveys, of molybdenum, tungsten, and gold properties in New Zealand. Regional and detailed geological mapping and drill-core logging of epithermal gold systems in Indonesia. (On contract while completing Ph.D. studies.)

Stokes Exploration Management, 1980

Conducted helicopter-supported base and precious-metal exploration project in BC, Canada. Work included regional and detailed geological mapping and core logging.

Gulf Canada Resources, 1979

Coal and oil & gas exploration in the foothills region of Western Canada Basin. Interpreted seismic profiles and stratigraphic and electric logs, prepared subsurface structural maps, evaluated land sales, generated oil and gas plays, conducted geological mapping of coal seams and logging of percussion drill chips, and interpreted electric logs.

APPENDIX O.4
RESUMES – KEY PERSONNEL

BOWMAN

Kent J. Lang, MSc

Vice President - Mining

Education

Ph. D., Soil Science/Land Use Planning, Montana State University (Not Completed), 1985

M.S., Soil Science, North Dakota State University, 1983

B.S., Agronomy/Soils, Colorado State University Fort Collins, Colorado, 1976

Areas of Expertise

Open Pit Mine Dewatering/ Depressurization

Heap Leach Dynamics Technology and Monitoring Techniques

Mine Site Characterization, Permitting, Compliance, and Closure

Kent Lang is Mine Group Leader / Principal at Bowman. Kent has over 40 years of technical, operations / organization management, and business development experience with mining and consulting industries in an international market. Projects managed have ranged from several hundred thousand dollars to tens of millions of dollars in value. The scope of projects that he has directly managed have included mine development, mine reclamation, mine water supply, mine dewatering, heap leach dynamics, environmental site characterization and remediation, environmental permitting and compliance, and construction quality assurance. The location of projects have included sites and facilities in Arizona, Utah, Nevada, New Mexico, Montana, Texas, Oklahoma, Idaho, Washington, Mexico, Chile and Saudi Arabia.

Experience

Minera Penasquite/Goldcorp, Integrated Mine Dewatering Services | *Zacatecas, Mexico*
Developed and managed approximately $90M in integrated mine dewatering services during the period 2007 to 2015. Integrated services included hydrogeology and engineering consulting, pilot hole drilling and hydraulic testing, production well drilling, construction and development, pump procurement / installation and well field management / optimization.

ASARCO, LLC Ray Mine Reactivation of Historic Leach Stockpiles | *Southeast, AZ*
Pilot for reactivation / secondary recovery of copper from historic leach stockpiles. High precision characterization program that used advanced WL geophysics, borehole samples and surface geophysics was used to target specific zones within the heap for pressurized well injections of raffinate.

American Bonanza, Copperstone Gold Mine Integrated Development Services - Quartzite | *Southeast, AZ*
As a project manager, Kent managed integrated mine development services for small underground gold mine, which included acquisition of aquifer protection, air quality, stormwater pollution prevention and other environmental permits, design of TSF and solution reclaim pond, geotechnical and hydrogeologic / dewatering analysis in support of design and permitting of underground mine operations. Environmental permits were acquired in record time for a mine operation in the state of Arizona.

Federated Metals Corp. (ASARCO, Inc.), Former Sand Springs Zinc Smelter Site (ODEQ), Brownfields Redevelopment Project | *Sand Springs, OK*
Developed and implemented closure and redevelopment plan for a former Federated Metals zinc smelter plant site property. Closure activities included remedial investigation / feasibility study, risk assessment, remedial design and plans and specifications for redevelopment of the former zinc plant site into a commercial property for retail businesses including a Super Walmart. Project received EPA's Phoenix award as highly successful example of a Brownfields redevelopment project.

Bowman

Kent J. Lang, MSc

Vice President - Mining

Rio Tinto, Former Capitol Castings Site Groundwater Remediation | *Tempe, AZ*
As project manager, Kent developed closure strategy based on integrated regulatory and remedial approach for a 1, 1-DCE plume associated with steel foundry. Remediation of 1, 1-DCE is based on In-situ Reactive Zone (IRZ) Enhanced Reductive Dechlorination (ERD) proprietary technology. Site remediation and closure work was managed under the Arizona Department of Environmental Quality (ADEQ) Voluntary Remediation Program (VRP).

Houston Lighting & Power / Utility Fuels, Inc., Jewett Mine Environmental Services Program | *Huntsville, TX*
As director of environmental services, Kent was responsible for acquisition and renewal of surface mining and reclamation permits (SMCRA), Natural Pollutant Discharge Elimination System (NPDES) permits, water rights and use permits, and air quality permits for a 7.5 mty lignite surface mine operation. Also, responsible for environmental compliance reporting, government, and regulatory affairs.

Bowman

Alonso Vidal, PE

Project Manager

Education

B.S., Geological Engineering, University of Arizona - Tucson

Registrations

Professional Engineer: Arizona (#54517), Texas, Nevada

Areas of Expertise

Stormwater Control: Dams, Channels, Hydrology, Hydraulics

Pipelines: Hydraulics, Slurry, Water Supply

Mining Facilities: Tailing Dams, Leach Pads, Reservoirs

Commercial Development: Plats, Site Civil Plans, Airports

Alonso Vidal is a licensed civil engineer and project manager for Bowman with 30 years of experience. He has extensive experience with stormwater control, pipelines, mining facilities, and commercial development.

Experience

Mammoth Leach Pad | *Marana, AZ*
Project manager and lead engineer in the design and construction of 70-acre copper leach pad. Project includes the installation of HDPE and GCL liner over the entire facility with a subdrain system and the preparation of a full set of construction documents.

Lone Star Mine | *Safford, AZ*
Performed hydrology analysis to determine flows in the natural watersheds before and after the Lone Star Project. Determined retention dam locations, and capacity required, capacity available, and created drawings of the dam design, layout, and footprint. Completed HEC-RAS analysis of a braided wash in critical locations associated with the project to support permitting activities.

Seven Oaks Dam | *San Bernardino, CA*
Project engineer and quality control manager for the construction of a 510 feet tall rock-fill dam. Project includes the design and construction of two cofferdams and related CMP culverts, monitoring of downstream water turbidity and design and construction of turbidity mitigation structures.

Hydromet - Hydraulic Audit | *Miami, AZ*
Project manager and lead engineer for the review of the hydraulics of the leach solution pumping and distribution system. Project included a preliminary survey of the pipeline network and fittings, and hydraulic analysis with numerical simulation model (WaterCad).

Regional Airport - Fire Pump Station | *Marana, AZ*
Lead engineer for the design of a fire suppression systems including pump house, two water supply wells, 1.5-million-gallon steel storage tank, 3 miles of pipeline, hangar sprinkler systems, and runway fire hydrants. Prepared construction plans, specifications and cost estimate. Project also included the construction administration and oversight.

Lower Santa Ana River Project | *Santa Ana, CA*
Construction project engineer and quality control manager for the construction of 5 miles of concrete lined river channel. Included elaboration of the quality control program for grading 5 miles of the Santa Ana riverbed and placing of 75,000 cubic yards of Portland cement concrete liner and sub drain system. Coordinated subcontractor's work and supervised concrete production and placement.

APPENDIX O.5
RESUMES – KEY PERSONNEL

PATERSON & COOKE

Robert Cooke

Principal

Dr. Robert Cooke, a Director of Paterson & Cooke's Denver, Colorado practice, founded Paterson & Cooke with Dr. Angus Paterson in 1991. Robert has extensive international experience with mine tailings and backfill, long distance slurry pipelines, hydraulic hoisting and marine mining applications.

Robert has written numerous technical papers and lectures at several courses presented by P&C and other institutions. Robert serves on technical tailings and investment assurance review panels for several mining companies and provides expert technology development review and guidance for clients.

Qualifications

1984, BSc Civil Eng
University of Cape Town
1986, MSc Eng
University of Cape Town
1991, PhD
University of Cape Town

Professional Status

ECSA PrEng (No. 920228)
MMSA Qualified Person
SAIMM Competent Person

Professional Affiliations

Member of the Mining and Metallurgical Society of America (MMSA)
Member of the Society for Mining, Metallurgy, and Exploration (SME)
Member of the Canadian Inst. of Mining, metallurgy and Petroleum (CIM)
Fellow of the Southern African Institute of Mining and Metallurgy (SAIMM)

Specialization

Mine tailings systems
Pump and pipeline systems
Gravity flow systems
Hydraulic hoisting
Technical review
Training courses

Experience

Long Term Tailings Strategy Development
Project Director leading P&C's team supporting a major mining company with the development of a long-term tailings strategy for their global operations.

Rajpura Dariba Hydraulic Hoisting, India
Project Director responsible for the prefeasibility development of a 1 million ton per year hydraulic hoisting system.

Minas Rio Ore Pipeline, Brazil
Project Director responsible for P&C's support of the re-start and ongoing support of the 530 km iron concentrate slurry pipeline.

Twin Metals Project, USA
Project Director responsible for tailings and backfill aspects for the pre-feasibility study which includes a 30 km overland tailings delivery pipeline.

Frac-Sand Slurry Pipeline, USA
Project Director responsible for the early feasibility development of an 80 km slurry pipeline transporting frac sand.

Quellaveco Project, Peru
Technical Review Panel member for tailings aspects of this major copper project in Peru.

Malmbjerg, Greenland
Project Director responsible for the development of a preliminary economic study investigating ore and tailings transport options.

Syncrude, Canada
Technical review and assessment of operating issues experienced by a froth pipeline.

Canadian Malartic Tailings Upgrade, Canada
Project Director responsible for basic engineering of tailings pumping system upgrade.

Kensington Gold Mine Tailings and Backfill, USA
Project Director responsible for assessment and review of the tailings delivery systems and paste backfill plant to optimize reliability and capacity.

McClean Lake Tailings Deposition, Canada
Project Director responsible for investigation to methods for optimizing the sub-aqueous tailings deposition system.

Syncrude Hydrotransport Pipelines, Canada
Project Director responsible for investigation into the cause of two hydrotransport pipeline sanding events. The scope included recommendations to mitigate against the risk of future events.

Kearl Tailings Disposal Modelling, Canada
Project Director responsible for a CFD investigation into the flow behavior of fine tailings deposited in layers.

Ekati Diamond Mine Tailings, Canada
Project Director responsible for upgrading the tailings delivery pump and pipeline system.

Paracatu Secondary Gold Recovery, Brazil
Project Director responsible for a CFD based investigation into recovery gold from a tailings pipeline using flotation and gravity sedimentation techniques.

Suncor Permanent Aquatic Storage System, Canada
Project Director responsible for a pilot scale investigation into dewatering polymer treated mature fine tailings using solid-liquid separator technology. The scope flow sheet development for the full scale system.

Quellaveco Tailings, Peru
Project Director responsible for review of tailings delivery options.

Turquoise Ridge Hydraulic Hoisting Study, USA
Project Director responsible for a conceptual investigation into hydraulic hoisting of gold ore.

Geoalcali Paste Backfill, Spain
Project Director responsible for laboratory test work and pre-feasibility level engineering of a paste backfill system.

Vaudreuil Residue Disposal, Canada
Project Director responsible for laboratory test work and pre-feasibility level study for a pump and pipeline system for alumina refinery residue disposal.

Antamina Tailings Study, Peru
Project Director responsible for process aspects of a study investigating alternate tailings deposition arrangement to extend the life of the tailings facility.

Paracatu Gold Mine Tailings Pipeline, Brazil
Project Director responsible for remedial measures to restore operation of a 42 inch tailings pipeline and provide ongoing operational support.

CNRL Inline Flocculation Pilot Investigation, Canada (2014)
Project Director responsible for pilot investigation of dual inline polymer system for treating MFT.

Bauxite Residue, USA
Project Director responsible for site investigation to measure rheological properties of red to obtain parameters for pipeline design.

Esperanza Tailings Delivery, Chile
Project Director responsible for feasibility engineering of new thickened tailings delivery system.

Chevron Questa Mine Tailing Project, USA
Project Director responsible for detailed engineering of thickened and filtered tailing system.

Dead Sea Works, Israel
Project Director responsible for development of a conceptual waste salt disposal system.

CNRL Horizon Mine Pit Dewatering, Canada
Project Director responsible for development of a conceptual pit dewatering system.

Suncor Tailings Reclamation Operations, Canada
Member of team tasked with optimizing the current TRO operations at Suncor.

Pebble Project, USA
Project Director responsible for prefeasibility engineering of on-site pump and pipeline systems.

Morenci East Dam Tailing Expansion, USA
Project Director responsible for feasibility engineering of 125,000 tpd tailings delivery system and cyclone facilities.

Sierrita Tailing Expansion, USA
Project Director responsible for a number of investigations into tailing expansion options for Sierrita including filtered tailings.

Cerro Verde Expansion, Peru
Project Director responsible for feasibility and basic engineering of 240,000 tpd tailings delivery system and cyclone station facility.

Syncrude Centrifuge Cake Transport, Canada
Participated in several studies and field trials investigating centrifuge cake pumping systems. Developed shear conditioning techniques to reduce the cake rheology.

Chuqicamata, Chile
Expert advisor for project to investigate future tailings disposal systems for the 180,000 t/d operation. The two-year contract included on site pilot plant investigations.

Joslyn North Mine Project, Canada
Member of specialist team convened by Thurber Engineering tasked with developing an Alternate Tailings Plan for the Joslyn North Mine project. The scope of work includes tailings and centrifuge cake pump and pipeline systems.

Syncrude Slurry System Reliability Improvement, Canada
Detailed review and analysis of Syncrude's North Mine and Aurora Mine hydrotransport and coarse tailings pump and pipeline systems with the objective of recommending design and operating practice improvements to maximize component operating life and system reliability.

Esperanza, Chile
Hydraulic design review and specification for a 100,000 t/d paste tailings disposal system. The project is in construction phase.

Idaho Cobalt, USA
Project Director responsible for test work, hydraulic design and engineering of an underground paste backfill delivery system.

Morenci, USA
Project Director responsible for test work, hydraulic design and feasibility engineering of an autoclave residue delivery system.

Efemçukuru, Turkey
Project Director responsible for test work, hydraulic design and engineering of an underground paste backfill delivery system.

Sierra Gorda, Chile
Project Director responsible for test work, hydraulic design and feasibility studies for 100,000 t/d tailings delivery system.

Pebble Project, Alaska
Project Director responsible for test work, hydraulic design and feasibility studies for 360,000 t/d tailings delivery and return water systems.

Porgera, Papua New Guinea
Project Director responsible for hydraulic design of an underground paste backfill delivery system.

Reko Diq, Pakistan
Expert review of well field water supply and delivery system to proposed new mine.

Malmbjerg Project, Greenland
Project Director responsible for design of cyclone station and tailings delivery system design.

Fort Hills Project, Canada
Expert review of Oil Sands hydrotransport and tailings pipeline systems.

Yanacocha Gold Mine, Peru
Project Director responsible for test work, hydraulic design and detailed engineering of a new high concentration tailings system.

Peace in Africa, Nambia
Project Director responsible for test work, process and hydraulic design, and detailed engineering of front end for De Beers sea diamond mining vessel.

Debswana, Botswana
Project Director responsible for a project to investigate the optimum integrated waste disposal strategy for Debswana mines with a view to minimising water consumption.

Rustenburg Base Metal Refinery, South Africa
Project Director responsible for an on-site pipe loop investigation to determine the flow behaviour of slurries in the magnetic concentration and leaching sections. The information forms the basis of slurry pipeline system design software package developed by PCCE for Anglo Platinum.

Las Cenizas Backfill System, Chile
Preliminary design of an underground tailings disposal system for Las Cenizas Mine.

Cuiaba Mine Backfill and Tailings, Brazil
Project Director responsible for the Cuiaba Mine expansion feasibility study covering the following aspects: backfill preparation plant, tailings thickening facility, underground backfill distribution system, overland thickened tailings pumping systems and return water pumping systems.

Lisheen Paste System, Ireland
Project Director responsible for PCCE's role in the project which included pipe loop test data review and analysis, hydraulic design, transient assessment, pipe stress analysis and mechanical design of the piping and support system.

Anglo Platinum, South Africa
Project Director leading a development project aimed at implementing hydraulic hoisting technology in platinum mines.

De Beers Marine, Namibia
Project Director responsible for the process design, hydraulic design and control philosophy of a jet pump based feed system for inline pressure jigs for the De Beers Marine mining vessels.

Orapa Mine Slurry Pumping System, Botswana
Project Director responsible for the upgrade of the Orapa slurry pumping systems. The working included on site rheology measurements, process and hydraulic design, mechanical design and commissioning.

Jwaneng Recrush Plant Co-Thickening, Debswana, Botswana
Project Director responsible for the generation of a Class III cost estimate for the upgrade of the Recrush Plant Co-Thickening Process. The work included hydraulic design, costing, detailing, risk assessment and construction and commissioning planning.

Cuiaba Concentrate Pipeline, Brazil
Project Director responsible for a 16 km concentrate pipeline feasibility study. The work included rheology and material property tests, pipeline route evaluation, process and hydraulic design and a detailed risk assessment.

Boulby Mine Backfill System, United Kingdom
Project Director responsible for the implementation of a backfill system for Cleveland Potash's Boulby Mine. The work included on site loop tests, backfill plant design, underground backfill reticulation system design and commissioning.

Corridor Sands Thickened Tailings Pumping System, Moçambique
Responsible for the process and hydraulic design of the non-Newtonian thickened tailings slurry pumping system for the Corridor Sands project.

Ramu Nickel Laterite Pipeline, Papua New Guinea
Audit of a proposed design for a 140 km overland non-Newtonian slurry pipeline traversing mountainous terrain. Prepared a new design for the pump and pipeline system.

Namdeb Floating Treatment Plant Elutriator, Namibia
Responsible for hydraulic and process design of a new elutriator for Namdeb's Floating Treatment Plant. The elutriator which treats 2 500 t/hr of ore was successfully commissioned in November 1999.

Kristineberg Backfill System, Sweden
Responsible for the design of 135 t/hr classified tailings backfill system for Boliden's Kristineberg base metal mine.

Serina Kaolin Slurry Pipeline, South Africa
Project Manager responsible for the project. Specific responsibilities included hydraulic and engineering design of the non-Newtonian kaolin slurry and return water pumping system, process plant design and layout, tender documentation, adjudication, contract administration, commissioning and operator training.

Backfill Systems, Brazil
Responsible for the design of backfill distribution systems for Mineração Morro Velho's Raposos, Mina Vehla and Cuiaba gold mines. Supervised slurry test loop tests conducted at the Queiroz metallurgical plant to obtain design information for the Raposos backfill system.

Mina Grande Hydrohoist Project, Brazil
Responsible for a technical evaluation of a proposed hydraulic hoisting system for Mineração Morro Velho's Mina Grande gold mine.

Publications

Kujawa, C., J. Winterton, R. Jansen, R. Cooke (2019) "Innovative Process Engineering to Create Better Tailings Facilities", Tailings 2019, Santiago, July.

Cooke, R. and J. Stowe (2019) "New Approaches and Technology for Tailings Pipeline Design and Operation", SME, Denver, February.

Stowe, J. R. Cooke, I. Farrell, R. Martinson (2018) “Design Considerations for Distributed Tailings Deposition Systems”, Tailings and Mine Waste, Keystone, CO, USA, September/October.

Cooke, R. and J. Stowe (2018) “Developments in Tailings Pipeline Transportation”, Tailings 2018, Santiago, July.

Stowe, J., Farrell, I., Treinen, J.M., Cooke, R. (2014), “Method for measuring rheology at low shear rates”, Hydrotransport 19 Conference Sept. 24-26 2014, Golden, CO, USA.

Treinen, J.M., R. Cooke and D. Znidarcic (2014) “A discussion of the critical drivers for tailings beach flows”, Proc. of the 17th Int. Seminar on Paste and Thickened Tailings. eds Jewel et al., Australian Centre for Geomechanics: Perth. pp 19-30.

McGuinness, M and R Cooke (2011) “Pipeline Wear and the Hydraulic Performance of Paste Backfill Distribution Systems” Proc. Minefill 2011, SAIMM, Cape Town, South Africa, April.

Keevy, M and R. Cooke (2010) “Optimizing Deposition Concentration at Minera Yanacocha, Peru”, Tailings and Mine Waste 2010, Vail, Colorado USA, October 2010.

Treinen, J.M., R. Cooke and C. Salinas (2010) "Energy Induced Rheology Reduction of Flocculated Slurries", 18th Int. Conf. on Slurry Handling and Pipeline Transport, Hydrotransport 18, Brazil, September 2010.

Treinen, J.M., R. Cooke and C. Salinas (2010) "Energy Induced Rheology Reduction of Flocculated Thickened Tailings – Pipeline System Design Methodology", Paste 2010, Australian Centre for Geomechanics, Toronto, Canada, May 2010.

Salinas, C., R. Martinson and R. Cooke (2009) "Shear and Rheology Reduction for Flocculated Thickened Tailings", Paste 2009, Australian Centre for Geomechanics, Viña del Mar, Chile, April 2009.

Cooke, R. (2008) “Design Considerations for Paste and Thickened Tailings Pipeline Systems”, 1st International Oil Sands Tailings Conference, Edmonton, Alberta, Canada, December 2008.

Cooke, R. (2008) “Pipeline Design for Paste and Thickened Tailings Systems”, Tailings and Mine Waste ’08, Vail, Colorado USA, October 2008.

Keevy, M., B. Busani and R. Cooke (2008) "Thickened and Paste Tailings Pumping Systems for Orapa Mine", Paste 2008, Australian Centre for Geomechanics, Perth, Australia, May 2008.

Vietti, A.J, R. Cooke, K. Ntshabele, M. Cooks and B. Busani (2008) "Rheomax and Water Conservation at Orapa Mine", Paste 2008, Australian Centre for Geomechanics, Perth, Australia, May 2008.

Goosen, P.E. and R Cooke (2007) “Hydraulic Scale-Model Tests for Slurry Handling Equipment”, Hydrotransport 17, SAIMM/BHR, Cape Town, May 2007.

Cooke, R (2007) “Backfill Pipeline Distribution Systems – Design Methodology Review”, MINEFILL2007, Montreal, Quebec, Canada, April 29 – May 3, 2007.

Keen, M., M Fehrsen, and R Cooke (2007) “Boulby Mine Backfill System: Operational Experience”, MINEFILL2007, held in Montreal, Quebec, April 29 – May 3, 2007.

Cooke, R. (2007) "Thickened and Paste Tailings Pipeline Systems: Design Procedure – Part 2", Paste 2007, Australian Centre for Geomechanics, Perth, Australia, April 2007.

Cooke, R. (2006) "Thickened and Paste Tailings Pipeline Systems: Design Procedure – Part 1", Paste 2006, Australian Centre for Geomechanics, Limerick, Ireland, April 2006.

Busani, B., A.M. Copeland, R. Cooke and M. Keevy (2006) "A Holistic Approach to Optimise Process Water Retention and Residue Disposal for Orapa Mines", Paste 2006, Australian Centre for Geomechanics, Limerick, Ireland, April 2006.

Cooke, R. (2005) "High Concentration Tailings Transportation System Optimisation", Paste 2005, Australian Centre for Geomechanics, Santiago, Chile, April 2005.

Martinson, R., Cooke, R., Stipo, N., (2005) "Cabildo Mine Backfill System", Paste 2005, Australian Centre for Geomechanics, Santiago, Chile, April 2005.

Van den Berg, G. and R. Cooke (2005) "Hydraulic Hoisting Technology for Platinum Mines", Platinum Adding Value Conference, SAIMM, Sun City, October 2004, also published in Journal of South African Ins. Mining and Met., vol 105, No 5, pp 323 – 332, 2005.

Wilkins, M.J., C. Gilchrist, M. Fehrsen and R. Cooke (2004) "Boulby Mine Backfill System: Design, Commissioning and Operation", 16th Int. Conf. on Slurry Handling and Pipeline Transport, Hydrotransport 16, Chile, April 2004, also presented at Minefill 2004, Beijing, China, September 2004.

Cooke, R., McDougall, S. (2003) "Elutriation – A Novel Way of Solving a Screening Problem", 4th One day seminar on hydraulic transport in the mining industry, Johannesburg, South Africa, April 2003.

Cooke, R. (2002) "Laminar Flow Settling: The Potential for Unexpected Problems", 15th Int. Conf. on Slurry Handling and Pipeline Transport, Hydrotransport 15, Canada, June 2002.

Cooke, R. (2001) "Paste Reticulation Systems: Myths and Misconceptions", Minefill 2001, Society Mining, Metallurgy and Exploration Inc., 2001, pp 3-12.

Cooke, R. (2001) "Design Procedure for Hydraulic Backfill Distribution Systems", Journal of the South African Institute of Mining and Metallurgy, vol. 101, 2001, no. 2, p. 97-102.

Cooke R., Johnson G., (1999) "Laboratory Apparatus for Evaluating Slurry Pipeline Wear", 14th Int. Conf. on Slurry Handling and Pipeline Transport, Hydrotransport 14, Maastricht, The Netherlands, September 1999.

Cooke R, (1999) "Design Procedure for Hydraulic Backfill Distribution Systems", 101st Annual General Meeting of Canadian Institute of Mines, Calgary, May 1999.

Cooke R., Gericke D., Paterson A. J. C., (1998) "Design of Hydraulic Backfill Distribution Systems: Lessons from Case Studies", Minefill '98, the 6th International Conference on Mining with Backfill, 14 - 16 April 1998, Brisbane, Australia.

Cooke, R. (1996) "Selecting Appropriate Valves for Slurry Applications", S. A. Pump Man. Assoc. Annual Conf., 27-28 August 1996.

Cooke, R. (1996) "Design of Deep Mine Backfill Distribution Systems", 13th Int. Conf. on Slurry Handling and Pipeline Transport, Hydrotransport 13, South Africa, 3-5 September 1996.

Cooke, R. (1996) "Pipeline Material Evaluation for the Mina Grande Hydrohoist System", 13th Int. Conf. on Slurry Handling and Pipeline Transport, Hydrotransport 13, South Africa, 3-5 September 1996.

Cooke, R., Goosen, P. (1996) "Design and Construction of the Noordhoek Kaolin Slurry Pipeline", 13th Int. Conf. on Slurry Handling and Pipeline Transport, Hydrotransport 13, South Africa, 3-5 September 1996.

Cooke, R (1995) "Pipeline Material Evaluation for the Mina Grande Hydrohoist System", 11th int. Conf. on Pipeline Protection, Italy, October 1995.

Cooke, R., Paterson, A.J.C., (1994) "Slurry Pipeline Transport Using Centrifugal and Positive Displacement Pumps", Developing & Implementing Effective Strategies to Enhance Pump & Valve Performance Reliability, S. A. Pump Man. Assoc., 23-24 February 1994

Cooke, R. (1994) "Horizontal Slurry Pipeline Design. Current Technology.", MineMech '94, South African Institute of Mechanical Engineers, 20-21 September 1994.

Cooke, R., Goosen, P., (1994) "Noordhoek Kaolin Slurry Pipeline", Proc. Slurry Transport in the Mining Industry (III), Hydraulic Conveying Association of S. A., 14 November 1994.

Goosen, P., Cooke, R. (1994) "Hydraulic Backfill Distribution System Design for Raposos Gold Mine", Proc. Slurry Transport in the Mining Industry (III), Hydraulic Conveying Association of S.A., 14 November 1994.

Cooke, R. (1994) "The Design of Hydraulic Backfill Distribution Systems for Deep Mines", IV Meeting of the Southern Hemisphere on Mineral Technology and III Latin-American Congress on Froth Flotation, 20-23 November 1994, Chile.

Cooke, R., Spearing, A.J.S. (1993) "The Influence of Binder Addition on the Hydraulic Transport Characteristics of Full Plant Gold Tailings Backfill", J. S. Afr. Inst. Min. Metall., Vol 93 No. 6, p 143-146.

Cooke, R., Lazarus, J.H. (1993) "Generalised Model for Heterogeneous Flow in a non-Newtonian Vehicle", 12th Int. Conf. on Slurry Handling and Pipeline Transport, Hydrotransport 12, Belgium, September 1993.

Cooke, R., Paterson, A.J.C. (1993) "Computer Aided Design of Slurry Pipelines", 12th Int. Conf. on Slurry Handling and Pipeline Transport, HYDROTRANSPORT 12, Belgium.

Cooke, R., Paterson, A.J.C. (1993) "The Design of Backfill Pipeline Distribution Systems using Computer Aided Techniques", Minefill '93, S. Afr. Inst. Min. Metall., September 1993.

Cooke, R. (1993) "Modelling the Flow of High Concentration Backfill Slurries", Minefill '93, S. Afr. Inst. Min. Metall., September 1993.

Cooke, R., Lazarus, J.H. (1993) "Hydraulic Transport Systems for Deep Mine Backfilling", J.S. Afr. Inst. Min. Metall., Vol. 93, No. 2, p. 25-30.

Cooke, R., Paterson, A.J.C. (1993) "Control of Fluid Flow in a Piping System", South African Provisional Patent, 30 April 1993.

Cooke, R., Spearing, A.J.S., Gericke (1992) "The Influence of Binder Addition on the Hydraulic Transport Characteristics of Classified Tailings Backfill", J.S. Afr. Inst. Min. Metall., Vol. 92, No. 11/12, p. 325-329.

Goosen, P.E., Cooke, R., Lazarus, J.H. (1992) "Hydraulic Transport of Heavy Mineral Concentrates by Pipeline", Proc. 7th Int. Symp. on Freight Pipelines, Wollongong, Australia, July 1992, p. 109-113.

Cooke, R., Lazarus, J.H. (1992) "The Hydraulic Transport of Dense Phase Backfill Slurries", Proc. 7th Int. Symp. on Freight Pipelines, Wollongong, Australia, July 1992, p. 103-107.

Cooke, R., Steward, N.R. (1992) "Energy Dissipator", South African Patent.

Goosen, P.E., Cooke, R., Lazarus, J.H. (1991) "Hydraulic Transport of Heavy Mineral Concentrates by Pipeline", Proc. Slurry Transport in the Mining Industry (II) - Hydraulic Conveying Association of S.A.

Cooke, R., Lazarus, J.H. (1991) "Hydraulic Transport of Backfill - State of the Art", Proc. Slurry Transport in The Mining Industry (II) - Hydraulic Conveying Association of S.A.

Cooke, R., Lazarus, J.H. (1990) "Hydraulic Transport of Mixed Coarse Ash and Fly Ash by Pipeline", Proc. First National Symposium - South African Coal Ash Association, Paper 7, p. 7.1-19.

Cooke, R., Lazarus, J.H. (1988) "Isokinetic Sampling Probe for Slurry Flows", Proc. 11th International Conference on The Hydraulic Transport of Solids in Pipelines, Hydrotransport 11, Stratford, England, Paper C1, p. 117-130.

Justin Jacobs

Project Engineer

Justin Jacobs has worked with Paterson & Cooke since November 2012 and is currently a Senior Engineer in the Denver office. His primary role is to analyze multi-phase slurry process equipment using the company's high-powered computational fluid dynamics (CFD) resources. In addition to this, Justin completes physical lab tests as CFD validation, models transient pipeline hydraulics, completes pipe stress and thermal analyses, and travels to mine sites to undergo online transient measurements using high speed data acquisition systems.

Justin completed his MSc at the University of Denver with a focus on fluid dynamics.

Qualifications

2005, BSc, Physics (Math)
Bates College

2012, MSc, Mech Eng.
University of Denver

Specialization

Computational fluid dynamics

Analysis and design for water hammer

Pipeline freezing analysis

Pipe stress analysis

Laboratory validation test work

Finite element analysis

Hydraulic design of pump and piping systems

Laboratory test equipment design

Pipeline erosion and wear predictions

Experience

Cliffs Mine Water Pipeline Freezing Analysis, Michigan, USA
To extend the cold temperature operations of a large diameter 8-mile-long water pipeline, a thermal analysis was completed showing the impact of the ambient temperature, wind speed, and flow rate. Pipeline thermal upgrade options were investigated and provided to the client.

De Beers Marine Mining, South Africa
Dynamic CFD analyses were completed to show the effect on the discharge moon pool and the dewatering bins from external waves and rolling of the new AMV3 ship during extreme weather conditions. Air entrainment issues were investigated in the dewatering bin at the higher flow rate conditions.

New Gold New Afton Mine Tailings Pipeline Transient Analysis, BC, Canada
Detailed engineering transient analyses were completed of multiple pipeline routes from positive displacement pumps with dampeners to specify the maximum transient loads along the pipeline. P&C engineers have supplied on-going support during the identification of pit subsidence issues and pipeline realignments. General operational guidelines of the pipeline have been supplied to the client.

El Abra Mine, Chile
The El Abra thickener rake was modelled using CFD to determine the expected torque and motor size required to restart the thickener rake under load. The P&C laboratory measured the sheared and unsheared material rheology, providing accurate CFD model inputs.

Bloom Lake Mine, Canada
CFD was used to replicate over-topping issues experienced at the cyclone overflow tanks, which fed a gravity flow pipeline. Analysis showed trapped air to be the main issue and strategically placed air valves solved the problems.

Eriez Flotation, Canada
CFD was used to simulate various design iterations of a slurry distributor in a flotation cell. CFD particle modelling was used to predict the overflow and underflow particle split size.

De Beers Marine Mining, South Africa
Dewatering bins for a new deep-sea diamond mining vessel were simulated with CFD under normal and extreme conditions. CFD particle simulations provided the expected overflow split size.

Kennecott Copper Mine, USA
CFD was used to evaluate the risk of a pump tank sanding out for various tank modifications, slurry levels and flow rates. Also, a minimum slurry level was recommended to avoid the formation of air vortices on the slurry surface above the pump suction inlet pipes.

Paragominas Mine, Brazil
By combining measured wall thickness and historical anomaly defect data from pigging campaigns with pipeline operating pressures and HGL information, a pipeline replacement plan was provided to the client.

Kearl Imperial Oil Mine, Canada
CFD was used to accurately model the co-deposition of flocculated fluid fine tailings into thickened tailings cells.

Paracatu Mine, Brazil
Several novel concepts are developed to recover both gravity recoverable gold (GRG) and fine gold from Paracatu's tailings pipeline. CFD was used as an engineering tool to assist in determining the effectiveness of the gold recovery concepts.

Nautilus Minerals, Australia
Seafloor Massive Sulphide (SMS) ore will be mined from one mile below sea level. Completed analytical and CFD analyses to determine the possibility of a blockage during a deep-sea riser dump event.

Canadian Malartic Mine, Canada
Feedwell uniformity distribution CFD investigation and design optimization to improve thickener underflow, clarity and rake torque performance.

Canadian Natural Resources Limited, Canada
Non-Newtonian multiphase CFD study of the mixing efficiency of flocculant polymer and MFT with varying in-line mixer configurations at varying polymer concentrations.

Chino Mine, USA
Site visit to survey and analyze cause for pipe leakage and anchor breaks. Report with stress analysis to help determine recommended fixes.

De Beers Snap Lake Mine, Canada
Transient analysis and report of pressure data taken on site of PD pump backfill system. Report quantified the large cyclical transients that are breaking anchors.

Mosaic Esterhazy Mine, Canada
Onsite transient pressure measurements and analysis in gravity-fed backfill pipeline system.

Krebs Pumps, USA
Analytical and computational pump nozzle load comparisons of inter-stage piping between centrifugal pumps with a bend, Victaulic gap, or rigid flange.

Publications

J Jacobs, M McGuinness & K Creber *Fluid Transients in Pumped Paste Backfill Systems.* International Conference on HydroTransport, 2022.

M McGuinness, K Creber, J Jacobs & B Haley *Investigation into the High Transients Experienced in Eleonore Mine's Pastefill Distribution System.* International Symposium on Mining with Backfill (Minefill), 2021.

J Jacobs, J Aydt, E Ketilson & M Treinen *An Alternative Tailings Deposition System for Uranium Tailings.* Tailings and Mine Waste 2019, 2019.

J Jacobs & C Kujawa *A Novel Approach to Thickener Rake Motor Sizing Using CFD.* 7th International Computational Modelling Symposium, 2019.

M Turney & J Jacobs *Ageing Assets – Long Distance Pipeline Integrity and Defect Assessment.* 20th International Conference on Hydrotransport, 2017.

M Turney & J Jacobs *Hydro Test of HDPE Lined Steel Pipe.* 20th International Conference on Hydrotransport, 2017.

J Jacobs *Optimizing Process Equipment from the Inside.* Colorado Mineral Processing Division Subsection of the Society of Mining and Metallurgical Engineers 66th Annual Conference, 2016.

JM Treinen & J Jacobs *The applicability of the Eulerian-Eulerian CFD Approach using Granular Kinetic Theory to Predict Particle Settling and Migration in Viscoplastic Fluids*. 17th International Conference on Transportation and Sedimentation of Solid Particles, Delft, September 2015.

J Jacobs, J Tripp, D Underwood & C Lengsfeld *Optimization of Micro-Textured Surfaces for Turbine Vane Impingement Cooling.* American Society of Mechanical Engineers Turbo Expo, 2013.

J Jacobs *Towards a Fluid Solid Interaction Model of a Dynamic Lung.* MSc Thesis, University of Denver, 2012.

J Jablonski, A Arecchi, J Jacobs & T Annicchiarco *Stray Light Rejection Techniques for LED Measurements Using CCD Based Spectrometers.* SPIE 7231: Light-Emitting Diodes: Materials, Devices, and Applications for Solid State Lighting XIII, 2009.

Rachel Jansen

Senior Process Engineer

Rachel joined Paterson & Cooke's North American practice in 2012 and is now a senior engineer/project manager in the process group focusing on tailings projects.

She has been involved in mineral processing for over sixteen years within various roles, including metallurgical engineering, consulting and laboratory management. Rachel has field experience in South Africa, Turkey, Indonesia, Mexico, Brazil and Australia. Her experience includes process design, feasibility studies, circuit mass balance, model building and simulation, tailings dewatering systems, paste backfill systems, comminution circuit surveys for plant optimization/auditing (including crushers, AG/SAG, HPGR, ball/rod mills and IsaMills) and metallurgical laboratory test-work.

Qualifications

2007, MPhil Met Eng.
JKMRC - University of Queensland

2004, GC MinRes.
JKMRC - University of Queensland

2003, B.Eng Mat.
University of Queensland

Professional Affiliations

Member of Society for Mining, Metallurgy & Exploration (SME)

Specialization

Filtered, paste and thickened tailings dewatering system design and study management

Test work program development

Comminution circuit surveying for plant optimization and auditing

Experience

BHP Integrated Tailings Strategy
Provided process consultation to BHP's Global Tailings Task Force for the development of asset-specific tailings strategy roadmaps. Managed the engagement and participation of original equipment manufacturers (OEM) in a strategy workshop with BHP. Developed and presented the options and proposals for each asset at BHP's long term tailings strategy workshop.

BHP Mechanical Dewatering Technology
Managed the second development phase of a mechanical dewatering technology mapping tool for BHP's Innovation, Sustainable Operations group. Coordinated and contributed to the development of a technical guidance for implementing "dry" stack tailings. Completed a desktop study comparison between filtration and microwave drying of Escondida tailings in conjunction with the University of Queensland.

Anglo American Quellaveco CPF Project Review, Peru
Participated in an independent senior technical review panel for the Quellaveco coarse particle flotation project feasibility study, focusing on the tailings system.

WAIO Whaleback Tailings Peer Review, Australia
Managed and contributed to P&C's peer review of Whaleback's tailings dewatering and transport identification phase study (IPS).

Confidential Project Filtered Tailings, Mexico
Developed a comprehensive test work program and conceptual design of a filtered tailings system. Work included the investigation of a novel chemical treatment for improved dewatering.

Agnico Eagle LaRonde Mine Tailings Filter Plant, Canada
Completed a feasibility study including thickener and filter plant design and costing and provided detailed engineering support. Project included test work and equipment bid evaluations.

AngloGold Ashanti Sunrise Dam Hydraulic Hoisting, Australia
Designed the conceptual crushing and grinding circuit for an underground mine with ore hydraulic hoisting to the surface processing plant.

BHP Minerals Americas Escondida Tailings Strategy, Chile
Developed future tailings options to conceptual level, including an engineering tailings option for splitting coarse and fine tailings for separate dewatering treatment. Work included a tailings dewatering technology landscape review (current and future) and high level costing.

Hindustan Zinc Rajpura Dariba Mine Hydraulic Hoisting, India
Designed and costed the pre-feasibility level crushing and grinding circuit for an underground mine with ore hydraulic hoisting to the surface.

Goldcorp Red Lake Mine Filtered Tailings, Canada
Completed a comprehensive test work program and conceptual design of a filtered tailings system. Work included trade-off studies to determine the optimum filter plant location and filtered tailings transport method.

Coeur Mining Palmarejo Mine, Mexico
Reviewed existing tailings system and developed alternative solutions, including thickened, paste and filtered tailings, and paste backfill. Optimized design for gold and cyanide recovery through filter cake washing. Scope of work included tailings dewatering, cake washing and paste backfill strength testing.

Barrick Cortez Operation, USA
Designed and costed the feasibility level comminution plant to produce underground paste backfill material from available waste rock. Work included development of the comminution test work program.

COSIA Tailings Research Working Group, Canada
Managed test work program for investigating effect of bitumen on thickening and consolidation of oil sands tailings.

Newmont's Yanacocha Mine, Peru
Managed tailings dewatering and rheology test work program.

Goldcorp's Minera Peñasquito, Mexico
Managed test work program for thickening and rheological characterization for feasibility study of expansion of the mine's tailings storage facility.

Todd Wisdom

Manager of Tailings

Todd has 30+ years of experience in designing, commissioning, and troubleshooting process equipment including large thickeners, filters and flotation cells. He has a good understanding tailing and their properties and what impacts their dewatering, transportation, and placement. Prior to joining Paterson & Cooke Todd lead FLS in the large tonnage tailings solutions market which includes the dewatering, conveying, and placement of all types of tailings. Organizational skills, innovation, and outside the box thinking are core strengths of Todd's. He also led the FLSmidth EcoTails® joint development project with Goldcorp and also spearheaded the development of the Colossal™ Automatic Filter Press designed specifically for large scale tailings dewatering. In addition, Todd is a recognized expert in the new and developing large scale filtered tailings market.

Qualifications

1990, BSc Eng (Chem Eng)
Oregon State University

1993, MSc Eng (Chem Eng)
University of Houston

Professional Affiliations

Member of the Society for Mining, Metallurgy and Exploration (SME)

Canadian Institute of Mining, Metallurgy and Petroleum (CIM)

Member of the Canadian Mineral Processors (CMP)

Specialization

Process Engineering for Tailings
Product, Process, and Research Development for Tailings

Experience

Manager of Tailings at Paterson & Cooke

- Responsible for the growth and expansion of P&C's footprint in tailings management systems design and implementation

Director of Tailings Solutions at FLSmidth

- Responsible for developing FLSmidth technology, business strategy, marketing, and process solutions for tailings dewatering.
- Developed from the ground up the FLSmidth Technology Trade Off Study offering growing it to a multi-million dollar per year product.
- Led the FLSmidth development of the EcoTails® technology in partnership with Goldcorp.
- Drove the development of the Colossal Automatic Filter Press
- Managed R&D in the development of lower OPEX filter media and high-capacity filter plates.
- Developed the EcoPasteTM technology for FLSmidth.
- Sold the largest Paste thickener for dewatering tailings for KAZ Minerals.

Director of Separation Products at FLSmidth

- Responsible for $ 400 MM separations product portfolio which included Filtration, Flotation, Sedimentation, and Centrifuge products.
- Managed support for commissioning of Separations products including tailings projects.
- Developed Process Engineering Solutions that included Thickeners, Filters, and Flotation cells.
- Developed and implemented FLS product portfolio strategy.
- Directly managed 35 global product managers and indirectly 10 regional product managers.
- Drove R&D to meet market needs.
- Negotiated large, complex, multi-year contracts and terms and conditions.
- Developed and maintained key client relationships.

Director of Filtration Products at FLSmidth

- Responsible for $ 100 MM filtration product portfolio.
- Developed Process Engineering Solutions that included Filtration.
- Managed support for commissioning of filter projects.
- Developed and implemented FLS filtration product portfolio strategy.
- Directly managed 21 global product managers and indirectly 5 regional product managers.
- Drove R&D to meet market needs.
- Negotiated large, complex, multi-year contracts and terms and conditions.
- Developed and maintained key client relationships.

Filtration Product Manager at Baker Process

- Executed and managed product launches in the filtration market.
- Commissioned 10 FGD tailings filter projects
- Developed and launched the steam dewatering product for gypsum production
- Developed and cultivated professional relationships with key customers and engineering firms
- Product Champion for filtration product line

Patents

Wisdom, T. W., et al., United States Patent 9,687,892., June 27, 2017, Combined Tailings Disposal for Minerals Processes

Publications

Wisdom, 'Recent Developments in Tailings Dewatering Technology' SME 2020, Phoenix Arizona March 2020

Rahal, Wisdom, Hanfland 'High Efficiency Filters for Tailings Applications' Tailings 2019, Santiago June 2019

Wisdom, 'Maintaining high availability and low operational costs for filtered tailings facilities', Paste 2019, Cape Town South Africa May 2019

England, Wisdom, Schoenbrunn, Chaponnel, MacNamara 'Recent Developments in FLSmidth Dewatering Technologies for Tailings Disposal to Maximise Water Recovery, 5th International Symposium on Innovation and Technology in the Phosphate Industry, Marrakech Morocco 2019

Wisdom, Jacobs, 'GeoWaste™: Continuous Co-mingled Tailings for Large Scale Mines' Paste 2018, Perth Australia June 2018

Wisdom, 'Developments in FLSmidth Dewatering Technology' 4th International Symposium on Innovation and Technology in the Phosphate Industry 2017, Marrakech Morocco 2017

Shoenbrunn, Wisdom, Neumann, Chaponnel 'Tailings Filtration Demonstration Plant' Paste 2016, Santiago Chile

Kujawa, Wisdom, Palmer 'Filtered Tailings' Chapter 8, Paste and Thickened Tailings – A Guide (Third Edition) 2015

Wisdom et al., "Solid Liquid Separation' Perry's Chemical Engineering Handbook 9th Edition, 2018

APPENDIX O.6
RESUMES – KEY PERSONNEL

AUSENCO

JIM NORINE, P.E.

Director, Minerals and Metals, Tucson - Project Sponsor

22 years of experience

Professional qualifications

Arizona, Mechanical Engineer, 2004
Professional Engineer, Nevada, 2009
Professional Engineer (Mechanical), Michigan, 2006
Professional Engineer (Mechanical), Minnesota, 2015
Professional Engineer, Idaho, 2019
Professional Engineer, Utah, 2019

Area of expertise

Project Management
Project Delivery
Process Piping
Construction Management

CAREER SUMMARY

Jim has over 22 years of total experience in Engineering, Procurement and Construction Management (EPCM), consulting on projects primarily in the mining industry, as well as commercial, environmental, and municipal work. Jim has over 16 years of project management experience in mining projects in the $100 million to $1.5 billion range. He also specializes in field commissioning and construction management, project estimating, scheduling and procurement. Additionally, he has extensive knowledge in project execution including planning of basic engineering through commissioning, and has successfully led a diverse, multi-disciplined, multi-firmed, typically multi-lingual team to meet client needs and accomplish project goals. Jim has completed projects in Mexico, Canada, the United States, Chile, Peru, and Anguilla. He is a licensed mechanical engineer in AZ, NV, MN, MI, ID, and UT. In his role at Ausenco, Jim serves as the Director, Minerals and Metals for the Tucson office and is our Area Representative in the Southwest US and Mexico.

PROFESSIONAL HISTORY

Director Minerals and Metals, Ausenco, USA	2020-Present
Manager of Studies, Ausenco, USA and Western Canada	2019-2020
Senior Project Manager, Sundt. Construction, USA	2018-2019
Project Manager, M3 Engineering & Technology Corp, USA	2000-2018
Field Research Assistant, University of Arizona Environmental Research Lab, USA	2000

RELEVANT EXPERIENCE

Ausenco, Tucson, AZ, USA (Aug 2019–Present). Role: Director, M&M:

- Arizona Lithium Big Sandy Scoping Study, AZ
- South32 Hermosa Field Support, AZ
- Seduli Lincoln Gold Mine Waste Rock design, CA
- Hycroft Pressure Oxidation Study, NV
- Hycroft AAO Feasibility Study, NV
- Aura Minerals Gold Road Desktop Study, AZ
- Confidential Due Diligence, NM
- Copper Fox Van Dyke PEA Update, AZ
- Hudbay Rosemont PFS Update, AZ
- Hudbay Mason PEA Update, NV
- PolyMet Mining NorthMet Project Execution Plan (PEP), Hoyt Lakes, MN
- Rio Tinto – Dry Stack Tailings Study, AZ
- Summa Silver NI 43-101 Resource Update, NV
- Las Chispas Feasibility Study, Sonora Mexico
- Newmont Ecotails Execution Planning, Zacatecas Mexico

- Newmont Penasquito Debottlenecking, Zacatecas Mexico
- First Majestic San Dimas Mill Modeling, Durango Mexico
- Atlantic Gold 15 Mile Stream, Nova Scotia
- Endeavour Silver Terronera Gap Analysis, Jalisco Mexico

OTHER EXPERIENCE

Sundt. Construction, Tempe, Tucson, AZ, USA (Mar 2018–Aug 2019):

- PolyMet Mining NorthMet Project Execution Plan (PEP), Hoyt Lakes, MN
- Goldcorp Penasquito Ecotails Execution Planning, Zacatecas MX
- Hudbay/Rosemont Fresh Water Delivery System, CMAR, Sahuarita, AZ, USA: Role: Subject Matter Expert – Pump Stations and Pipelines
- Wellington Microtech, Wellington, EPC, UT, USA (2018–2019). Role: Engineering Design Manager:
  - 3000-bpd renewable fuels micro-refinery to be built in Carbon County, Utah.
- Jerritt Canyon Gold (C/O Linkan Engineering), DBB, Elko, Nevada (2018). Role: USA: Engineering Manager/Project Engineer:
  - Tailings water treatment plant
  - Assigning Engineering firm in completing engineering
  - Provided procurement and field support.

M3 Engineering & Technology Corp., Tucson, AZ (July 2000–Mar 2018):

- PolyMet Mining NorthMet Project, Minnesota, USA, Pending delivery method (2015-2018), $1.2 billion, Role: Project Manager:
  - Authored NI-43-101 Feasibility Study for a Copper/Nickel concentrator and hydromet/Autoclave
  - In a two-year period, performed a variety of trade-off studies and analyses of the project for the Client
  - Performed an NI 43-101 Compliant Preliminary Economic Assessment Study for an expansion to 100,000 stpd.
- Grupo Mexico, Concentrator 2 EPCM, Sonora, Mexico (2011–2016):
  - $1.5 billion, Engineering Manager/Assistant PM from basic engineering through plant start-up; Copper Moly Concentrator processing 100,000 Mtpd
  - Project Manager for various smaller projects and studies including Concentrate Rail Transfer Station; Audit of copper heap leach pumping and piping systems; Copper raffinate neutralization pilot plant; Crushing and Conveying Safety Audit.
- Hudbay/Rosemont Project, Sahuarita, AZ, USA (Oct 2015–Feb 2016, Oct 2017–Mar 2018). Role: Seconded by Client as Piping and Mechanical Project Engineer:
  - Reviewing piping and mechanical design and specifications as Owner's agent
  - Key member of the Engineering Team for the (5,000-gpm) freshwater system.

- Freeport McMoRan/ "A" Thickener Replacement, Sierrita, AZ, USA (2015). Role: Study, Feasibility Project Manager:
  - Replacement of an active copper moly thickener in an operating plant.
- Kennecott Eagle Development Project, EPCM, Marquette, MI, USA (2006–2011). Role: EPCM Project Manager:
  - Project capital costs totalled over $300 million
  - Authored 2007 feasibility study including all capital and operating cost estimates
  - Successfully defended 2007 and 2010 (updated) feasibility studies to Rio Tinto Technical Evaluation Group (TEG) to ensure project funding
  - Executed and completed the mine services facilities EPCM including a 1,000-gpm reverse osmosis plant.
- Yamana Gold/Mercedes Project, EPCM, Sonora, Mexico (2009–2011):
  - $200 million; Project Manager from June 2009 through March 2010 for a 1,5000 tpd gold and silver Merrill Crowe project
  - Completed basic engineering, completed major capital purchases.
  - Augusta Resources/Rosemont Copper Project, EPCM, Sahuarita, AZ, USA (2009:). Role: Piping Discipline Lead:
- Goldcorp/Penasquito Project, Zacatecas, Mexico: Well piping and design specialist and trouble-shooter for a 50 well wellfield for a 100,000 TPD plant.
- Eureka Moly/Mt Hope Project, EPCM, Eureka, NV, USA (Nov 2008–Mar 2009). Role: Piping Discipline Lead:
  - The $700 million project was placed on hold.
- Frontera Copper/Piedras Verdes Project, EPCM, Alamos, Mexico (2005):
  - Engineering, Procurement, and Construction support of a 16-well fresh and potable water system, including the sizing of all pumps, tanks, pipelines and instrument selection
  - Also authored the O&M manuals for each well.
- Various Municipal, Commercial, and Small Mining Projects:
  - Tucson Electric Power Potable Water Conversion, Project Manager (2003–2008), $2,000,000
  - Hope Observatory – Modelling and design of HVAC and plumbing systems for a reinforced concrete observatory in Anguilla (2006)
  - Quadra Mining Carlota Copper Project – Construction water tank design (2005)
  - Giant Magellan Observatory – Thermal modelling of the enclosure for the Giant Magellan Observatory (2005), $1,000,000,000
  - Villa Grande Domesic Water Improvement District: Engineering and Procurement for a 250-gpm domestic well and tank for a rural housing development in Pinal County, AZ (2005), $500,000
  - Advanced Technology Solar Telescope – Thermal modelling and analysis, as well as design concept presentation for Client's technical review panel. (2004)

- Bombardier Alodine Booth – Retrofit design and Construction Administration for a large, heated aircraft paint stripping hangar. (2004), $1,000,000
- Canyon Water District – 6-mile pipeline, lift station and storage tank for 140 families in rural Gila County. Served as Project Engineer. (2002), $1,500,000

- Pima County Facilities Management:
  - Kino Hospital Sewage Ejector (2003/2004), $50,000
  - Downtown cooling tower replacement (2002), $300,000
  - Served as Project Engineer – performed Engineering, Procurement, and Construction Administration.
  - Kinross Gold/Refugio Reopening Project, EP, Maricunga, Chile (2003–2004):
- Design of mechanical systems for various support facilities including an in-slab heating system for a fully enclosed truck wash for off highway haul trucks.
- Kerr McGee Chemical Henderson Remediation Project, Engineering, Henderson, NV, USA (2003–2004). Role: Field supervision and on-site commissioning support for the Owner:
  - 2,000-gpm bio-remediation plant treating Ammonium Perchlorate contaminated groundwater.
- Pinal Creek Group, EPCM, Claypool, AZ, USA (2000–2002):
  - EPCM, Field Engineer for a major mining environmental clean-up project (9 months; 2000-2001)
  - Transitioned into a home office engineering support role for this project and remained involved until 2002
  - Involved in the field engineering and construction management of the following projects:
    - Hoopes #2 Well – 250-gpm commercial potable water well
    - Kiser Basin Well field – an extraction well field for the remediation of high pH, high metals groundwater consisting of over 30 wells
    - Lower Pinal Creek Well – an extraction well field for the remediation of high pH, high metals groundwater consisting of over 30 wells
    - AWC Well #3 and 4 – Commercial potable water wells in the 300-gpm range
    - Burch shaft to OP pump station pipeline – a five mile 26” HDPE pipeline and pump station improvements for the pumping of low pH water.

EDUCATION

B.S. in Mechanical Engineering, Northern Arizona University, USA	1998-2000

ADDITIONAL TRAINING

Aconex Document Management Software	2015
KY Pipe Surge 2000 Transient Modelling Software	2012

TA CAID – AWS Weld Inspection Procedures	2005
Electrical League of Arizona – Basic VFD Operation	2000
Carrier Advanced HVAC Design	2004

PROFESSIONAL MEMBERSHIPS

Society for Mining, Metallurgy, and Exploration (SME), USA	2009-Present
Arizona Mining Association (AMA) – Vice Chairman of Supplier Committee	2019
Asociación de Ingenieros de Minas, Metalurgistas y Geologicos de Mexico	2021
Mining AMIGOS	2018-Present
Mining Foundation of the Southwest, Member	2021

LANGUAGE

English and Spanish (Intermediate)

ERIN L. PATTERSON, P.E.

Manager, Minerals and Metals

17 years of experience

Professional qualifications

Arizona (54243)
Minnesota (55292)
Missouri (201523710)
South Carolina (32168)
NCEES Record Holder

CAREER SUMMARY

Erin has over seventeen years of professional experience in the Mining industry as a Process Engineer, Project Engineer, Project Manager and Qualified Professional. She has successfully completed numerous studies as well as EPC/EPCM projects. Erin's area of expertise lies in mining and metallurgical project development, including leading design and implementation of several solvent extraction unit operations for copper and other base metals. She has effectively collaborated with countless project teams that vary from small groups of two people (scoping studies) to as large as several hundred people (EPCM projects with a total value over $1 Billion in constructed cost). Erin is registered as a Professional Engineer in multiple states in the USA.

PROFESSIONAL HISTORY

Study Manager, Ausenco, Tucson, AZ, USA	2020-present
Project Manager/Engineering Manager, M3 Engineering, Tucson, AZ, USA	2008-2020
Project Engineer, United States Gypsum Company, Plaster City, CA, USA	2005-2008

RELEVANT EXPERIENCE

2020 – Present: Ausenco Engineering, Tucson, AZ. Study Manager

- Hudbay Minerals – Mason Project – Preliminary Economic Assessment update for the Mason Project (Project); a copper-molybdenum project located 75 km southwest of Reno. The project consists of an open pit with a throughput of 120kt/d and a 22-year LOM.

OTHER EXPERIENCE

2008 – 2020: M3 Engineering & Technology: Tucson, AZ

- Oceana Gold - Haile Gold Mine – A greenfield project located in South Carolina, USA. The milling facility has a design throughput of 7,000 STPD, including crushing, grinding, flotation, carbon-in-leach, refinery, reagents, and water treatment for mine contact water. The project had a capital cost of approximately $400 Million (USD) with construction substantially complete in the end of 2016 and first gold achieved January 2017.
- Project Roles:
- 2016-2018: Project Manager
  - Managed total staff of approximately 35 (office and field engineering, construction management, project services)
  - Assisted in scope definition for major construction contracts
  - Interfaced with authorities having jurisdiction over the project (state and county) regarding building and environmental permits
  - Field assignment
  - Managing on-going throughput increase and optimization projects.
- 2011-2016: Project Engineer
  - Oversaw development of engineering from feasibility to construction

- Oversaw procurement of major equipment and commodities
- Responsible for review of vendor documents for all procured equipment
- Participated in multiple NI 43-101 submittals
- Conducted HAZOP study for the project
- Engineering representative for the relevant portion of the EIS

- 2011-2017: Process Engineer
  - Responsible for metallurgical modelling and selection of unit processes, flow sheet development, and coordination of plant philosophy with multiple client teams
  - Professional Registrant for piping and instrumentation diagrams (P&IDs) and technical specifications for the project

EPC/EPCM Projects

- 2018 – 2020: Engineering Manager, Eramine Sudamerica, Centenario Lithium
  - Detailed design for an 800 person camp, pilot plant, and commercial lithium production facility.
- 2017 – 2019: Project Manager, Excelsior Mining, Gunnison Copper In-Sutu Leach
  - Engineering and construction management updates for the refurbishment and restart of Gunnison Copper solvent extraction
- 2017: Project Manager, Barrick, Pre-Oxidation Pilot Pad
  - Addition of a pilot pre-oxidation pad and pumping systems to an existing operation.
  - copper/molybdenum concentrator plant in Southern Arizona, USA
  - 2015: Project Manager, Hecla, San Sebastian Modifications
- Retrofitting an existing operation for additional reagents for a precious metal mill in Durango, Mexico
  - 2009-2010: Process Engineer, Augusta Resources, Rosemont Copper Mine
- Created and maintained P&IDs for 70,000 MTPD throughput copper/molybdenum concentrator plant in Southern Arizona, USA
  - 2008-2009: Process Engineer, GoldCorp, Peñasquito Mine
- Developed and maintained P&IDs for 130,000 MTPD throughput silver/lead/zinc concentrator plant in Zacatecas, Mexico
  - Studies (Scoping, Preliminary Economic Assessment, Pre-Feasibility, Feasibility) Project manager, process engineer and process lead on numerous scoping, preliminary economic assessments, pre-feasibility, and feasibility studies for mining projects located within North and South America. Works also included acting as Qualified Personnel for associated NI 43-101 report sign-offs.
- Asarco, Mission Mine, Process Optimization Study
- Barrick, Pueblo Viejo, Pre-Feasibility Study
- Coeur, La Preciosa, Preliminary Economic Assessment
- Eramet, Centenario Lithium, Definitive Feasibility Study

- Mercator Minerals, Creston Moly, Feasibility Study
- Hecla, San Sebastian, Scoping Study
- Hecla, Creede, Scoping Study
- Groupo, El Arco, Feasibility Study
- Oceana Gold, Haile Gold Mine, Feasibility Study
- Polymet, Northmet Project, Feasibility Study
- Wester Copper, Casino Project, Scoping Study
- Silver Standard Resources, Pitarrilla, Scoping Study
- Silver Standard Resources, Pitarrilla, Feasibility Study
- Wildcat Silver, Hermosa, Pre-Feasibility Study
  - 2005 – 2008: United States Gypsum Company, Plaster City, CA
  - Project Engineer
- Responsible for capital projects including process improvements and facilities management
- Compiled capital fund requests, interfaced with corporate engineering for works completion, managed procurement of materials, and managed construction contracts
- Managed plant facilities construction staffing and narrow gauge railroad operations

EDUCATION

B.S. in Chemical Engineering, University of Arizona Tucson, AZ 2005

PROFESSIONAL MEMBERSHIPS

Arizona (54243)

Minnesota (55292)

Missouri (201523710)

South Carolina (32168)

NCEES Record Holder

LANGUAGE

English

SCOTT MCLEOD, P.E.

Study Manager

13 years of experience

Area of expertise

Pump and Piping calculations, Solvent Extraction, and Electrowinning Facilities Wellfield Investigations, Booster Stations, Potable Water Storage Facilities, Water Transmission Mains, And Tailing, Flotation and Concentrate System Retrofits. Project Engineering and Management

Patent

United States Patent (US 8,294,292 B2), 2012

An inline power generating turbine designed to trickle charge remote location valve controllers located in irrigation pipelines.

CAREER SUMMARY

Scott is a registered Professional Mechanical Engineer with over 12 years experience in piping design, project engineering, and project management. He has worked on numerous processing, solvent extraction, and electrowinning facilities, as well as Gold processing and base metal concentrators. Having held roles that include Project Manager, Project Engineer and Piping and Mechanical Lead, Scott is well experienced in with the mining industry. His expertise includes wellfield investigations, booster stations, potable water storage facilities, water transmission mains, and tailing, flotation and concentrate system retrofits in addition to tracking budget and schedule, maintaining earned value metrics, managing subconsultants, invoicing, tracking, and preparing change management documents and coordination with various parties.

PROFESSIONAL HISTORY

Study Manager, Ausenco Engineering USA South Inc, AZ	Current
Sr. Project Manager, WestLand Resources Inc, AZ	2019-2021
Piping Discipline Lead / Piping Department Manager, M3 Engineering, AZ	2009-2019

RELEVANT EXPERIENCE

Ausenco Engineering USA South Inc. Tucson AZ, 2021. Study Manager:

- Konnex Feasibility Study
- Hudbay RP-21 PEA
- Hycroft Mining Desktop Study
- Hycroft AAO Feasibility Study
- Aura Minerals Gold Road Tails Reprocessing Study
- Seduli Lincoln Gold Mine Waste Rock
- Haile Gold Debottlenecking Study
- Haile Gold Thickener Underflow Pump Analysis

WestLand Resources Inc., Tucson AZ, 2019-2021. Senior Project Manager:

- Managed up to 8 projects at a time in the municipal and mining sectors for WestLand, ranging in value from $40,000 up to $800,000.
- Activities included tracking budget and schedule, maintaining earned value metrics, managing subconsultants, invoicing, tracking and preparing change management documents and coordination with federal funding agencies.
- Developed client relationships and wrote proposals for wellfield investigations, booster stations, potable water storage facilities, water transmission mains, and tailing, flotation and concentrate system retrofits.
- Provided training and mentoring to younger engineers and project managers to help them improve in skill and confidence.

OTHER EXPERIENCE

Augusta Resources Corporation, Rosemont Copper, copper and molybdenum processing facilities.

- Among many other duties, Scott worked on the sizing, layout and design of Raffinate and PLS pumps as well as the major slurry pumps and pipelines.
- He engineered and produced drawings for the buried utility piping including: the fire water systems for the SX/EW processing facility and the concentrator, process water feed from the pond to the head tank and potable water distribution.
- Scott was responsible for assembling the procurement documents for all the tanks onsite. He was also responsible for writing many of the design and fabrication specifications for tanks and pumps located on the property.

Mercator Minerals, El Pilar, copper solvent extraction and electrowinning facilities.

- Scott was responsible for the design and specification of the leach solution supply system, from the process plant to the leach fields as well as the leach field piping.
- As part of this work, he had to optimize and size the overland pipeline, balancing the pipe size and cost with line loss and subsequent horsepower required for the leach solution pumps.
- He was responsible for part of a trade-off study that looked at the most efficient method with the least amount of risk to supply molten sulfur to an onsite sulfur burner producing sulfuric acid.
- Scott provided preliminary pump specifications, pipeline sizing and specification, and preliminary physical piping drawing.

Grupo Mexico, Buena Vista Concentrator 2, copper and molybdenum processing facilities

- Scott was responsible for the specification, sizing, and purchasing of all slurry pumps. He was responsible for the design, drawings, and procurement of the process fluid storage and water storage tanks.
- Led the design, fabrication drawings, procurement and QA/QC of all pump and distribution boxes and served as general engineering support for other engineers; supplying methods, direction, and advice for duties they were assigned.
- Scott was part of a 3-man team responsible for on-site mechanical engineering support, troubleshooting systems integration during construction and pre-commissioning of the concentrator.

Metro Water Domestic Improvement District, NWRRDS Transmission Main.

- Scott managed the project which included the design of 7 miles of 24-inch ductile iron pipe and valves running from Marana Airpark to Oro Valley.
- The project was delivered to the client on time and 12% under budget. Some of his duties included obtaining permits from the Army Corps of Engineers, obtaining an easement from the Bureau of Reclamation, managing subconsultants, and stamping the final deliverable documents.

M3 Engineering and Technology, Tucson, AZ, (2009-2019). Piping Discipline Lead / Piping Staff Engineer

- Pipeline sizing for water, compressed air, and chemical services

- Participated in hazard and operability reviews
- Writing specifications for materials, equipment, and valves
- Physical piping design review
- Creation of overland piping drawings including plan and profile drawings, location of AVR and other pipeline devices, identification and creation of plans and sections for road and other utility crossings to be used for coordination between other disciplines and entities

Piping Discipline Lead, multiple projects in the United states, Mexico, and Argentina:

- Code and environmental permit compliance reviews for piping design
- Leading hazard and operability review
- Contributing to the project basis of estimate for the piping discipline
- Engineering calculations related to piping and fluid storage systems including: pipeline sizing, pipeline pressure capacity, total dynamic pump head, tank sizing, pump and gravity distribution box sizing, etc.
- Generation of purchasing documents such as ERFQ's, TBA's, LOR's, for pumps, tanks, valves, bulk piping materials, and other pipeline appurtenances
- Physical piping design review
- Physical piping drawing review to ensure correct technical content, clarity of presentation, conformance to company standards and ease of maintenance and operability for the client
- Stamping of all physical drawings and applicable specifications
- Management of engineering hours spent including productivity reports and tasks completed reports to project management team
- Creation and stamping of permitting reports for the State of South Carolina
- Collaboration with contracts group to create mechanical and piping installation contracts

Piping Department Manager

- Providing technical training to my engineers to expand their knowledge base competency in piping system design.
- Providing technical training to my designers to increase their knowledge of the systems they work with on a daily basis, allowing them to more effectively make informed design decisions in the course of their work.
- Checking documents such as plans, sections, isometrics prior to being issued for construction.
- Stamping drawings and specifications issued for construction.
- Managing the department workload by assigning engineers and designers to tasks and projects that will allow the employee to gain knowledge and skills while meeting the needs of the projects to which they have been assigned.
- Performing bid walks and writing proposals to generate work for M3 and the piping department
- Interviewing and hiring new employees

Molybdenum Flotation Concentrate Upgrades, Freeport-McMoRan Sierrita Operations.

- Scott managed and was the lead engineer for this project to rehabilitate the MFC Thickener and provided a new pumping system to transfer moly concentrate slurry to the Filter Feed Surge Tanks.

Villa Grande Domestic Improvement District, Nitrate Removal Ion Exchange System.

- Scott managed and was the engineer for the design and specification of an ion exchange system to remove nitrates from the water supply to meet ADEQ regulations.
- The project is going into construction on schedule and on budget.
- Duties included coordination with the client and the Water Infrastructure Financing Authority (WIFA), sizing and specification of equipment, subconsultant management, invoicing, and stamping deliverables.

Molybdenum Flotation Concentrate Upgrades, Freeport-McMoRan Sierrita Operations.

- Scott managed and was the lead engineer for this project which was to rehabilitate the MFC Thickener and provided a new pumping system to transfer moly concentrate slurry to the Filter Feed Surge Tanks

EDUCATION

BS Mechanical Engineering, University of Arizona	2009

ADDITIONAL TRAINING

PE Mechanical Arizona (57500)	2014
PE South Carolina (32866)	2015
PE New Mexico (24940)	2018

Mine Safety and Health Administration form 5000-23 trained

LANGUAGE

English

JORGE VELARDE, P.E.

Geotechnical Engineer

7 years of experience

Professional qualifications

Professional Engineer, Arizona, 2018

Area of expertise

Civil Engineering
Geotechnical Engineering
Heap Leach Facilities
Tailings Storage Facilities
Mine Closure

CAREER SUMMARY

Jorge is a Civil Professional Engineer with over 7 years of experience in geotechnical engineering for both mining and transportation projects. His mining experience includes civil, and construction projects, including heap leach and tailings facility design, permitting, construction, and closure. Geotechnical experience includes planning and oversight of field investigations, slope stability analyses in soil and rock, settlement analyses and pavement design. Mr. Velarde's professional experience has been primarily focused on the southwestern US and northern Mexico. He is a registered Professional Engineer in the state of Arizona and has a Master of Science in Geotechnical Engineering degree and a Bachelor of Science in Civil Engineering degree from the University of Texas El Paso.

PROFESSIONAL HISTORY

Project Engineer, Ausenco Engineering, Tucson, AZ	2021-Present
Staff/Project Engineer, Golder Associates, Tucson, AZ	2015-2021
Research Assistant, C.T.I.S., El Paso, TX	2011-2015

RELEVANT EXPERIENCE

Ausenco Engineering – Tucson, AZ. (2021 - Present). Project Engineer:

- Work in development of civil and geotechnical portions of prefeasibility and feasibility studies
- Experience in civil and geotechnical design for mine structures, including access and haul roads, foundations, heap leach pads, tailings storage facilities, and waste rock stockpiles.

Golder Associates – Tucson, AZ. (2015 - 2021). Staff / Project Engineer:

- Work in developing permit, design, and construction drawings of earthwork structures for the mining industry including heap leach pads and tailings storage facilities.
- Perform field investigations involving soil logging and rock core characterization for civil and geotechnical projects.
- Experience in construction management processes and quality assurance of mining construction projects.

CTIS – El Paso, Texas. (2011 - 2015). Research Assistant:

- Worked on federal and state funded research projects in transportation infrastructure and geotechnical engineering.

OTHER EXPERIENCE

- Hycroft Mine, Nevada, USA
  - Feasibility level civil earthworks design
  - Tailings Management Facility geotechnical field investigation and feasibility design
  - Waste Rock Stockpiles feasibility design

- Cordero Mine, Chihuahua, México
  - Conceptual level design of the heap leach facility
- Pan American Silver Dolores Mine, Chihuahua, México
  - Detailed construction design for two heap leach facilities
  - Supervised geotechnical investigation and construction activities
  - Engineering calculations, technical memorandums, plans, and design report
  - Development and Implementation of Operations, Maintenance, and Surveillance Manual and Emergency Response Plan
  - Served as deputy Engineer of Record for heap leach facilities
- Premier Gold Mercedes Mine, Sonora, México
  - Design lead for a new tailing's impoundment
  - Detail level construction plans
  - Technical memorandum and design report preparation
- Konexx Resources, Idaho, USA
  - PFS design of heap leach facility
- Hecla Velardeña Process Plant, Durango, México
  - Detailed construction design for tailings impoundment expansion
  - Field construction manager and construction quality lead
- Freeport McMoran Morenci Mine, Arizona, USA
  - Design of the Silver Basin Stockpile
- Resolution Copper Resolution Mine, Arizona, USA
  - Geotechnical and geological field investigation
  - Hydrogeological field tests as part of the Tailings Impoundment design
- Lluvia de Oro Mine, Sonora, México
  - Detailed construction design for heap leach facilities expansion
- Alamos Gold Mulatos Mine, Sonora, México
  - Closure definition and implementation plan
  - Closure design criteria for major facilities including pits, leach pads, ponds, and waste rock stockpiles.

EDUCATION

M.Sc. Geotechnical Engineering, University of Texas at El Paso	2015
B.Sc. Civil Engineering, University of Texas at El Paso	2014

PROFESSIONAL MEMBERSHIPS

Society for Mining, Metallurgy & Exploration (SME)

American Society of Civil Engineers (ASCE)

LANGUAGE

English / Spanish (Fluent)

LOURDES E. FOSTER

Lead Structural Engineer

28 years of experience

Area of expertise

Process Facilities
Electrowinning, Solvent Extraction, Tank Farms. Concentrators

CAREER SUMMARY

Lourdes has over 28 years of design and engineering for industrial projects, and 13 years as the Civil/Structural Department Manager. She has worked on projects of all sizes and budgets ranging from a few thousand dollars to multi-million dollars and performs structural designs and calculations. Lourdes prepares design construction drawings, standard detail drawings and specifications, including new facilities as well as additions, expansions, retrofits, upgrades and restoration of existing facilities.

The facilities include structures such as single and multistorey buildings and process facilities for the industrial sector as well as facilities for the water treatment industry. Such facilities include control rooms, MCC rooms, electrical buildings, electrical substations, pump stations, pedestrian bridges, pipe supports, duct supports, conveying system supports, dust collection system supports, cable trays supports, barges, concrete containments for water treatment, retaining walls, concrete storage for process liquids (for concentrate and for granular material), concrete foundations for buildings and for all types of equipment (including large vibrating equipment).

Lourdes' experience in mining industrial facilities include electrowinning, solvent extraction, and tank farms. Her experience in concentrators and other facilities involves designing and engineering for major process equipment such as crushers, SAG mills, ball mills, vertimills, isamills, HPGR's, thickeners, cyclones, vibrating screens, flotation cells, cleaner cells, scrubbers, samplers, cranes, hoppers, silos, bins, tanks, conveyors etc.

PROFESSIONAL HISTORY

Civil/Structural Engineer, Ausenco, Vancouver, BC, Canada	2019-present
Senior Structural Engineer, GOLDER ASSOCIATES	2017-2019
Senior Structural Engineer/Supervisor, MATRIX PDM ENGINEERING	2014-2016
Lead Civil/Structural Engineer, JACOBS/AKER SOLUTIONS	2010-2014
Civil/Structural Engineer, M3 ENGINEERING & TECHNOLOGY	1995-2010

RELEVANT EXPERIENCE

AUSENCO, Senior Structural Engineer 2021 to Present

- Senior Structural Engineer responsible for the design of the process grinding area of the Magino Project, Ontario Canada.
- Provided structural support for the Hycroft's POX Prefeasibility Study, Nevada, USA.

AUSENCO, Lead Civil/Structural Engineer for the Rosemont Project 2019

- Lead Civil/Structural Engineer for a major copper mine project in Pima County, Arizona. Unfortunately, the project was stopped after a few weeks.

GOLDER ASSOCIATES, Part Time, Senior Structural Engineer 2017-2019

- Designing structural steel and concrete foundations for industrial projects. Also, assisting in engineering design estimates, project proposals and answering RFP's.

MATRIX PDM ENGINEERING, Senior Structural Engineer/Supervisor 2014-2016

- Supervised, checked, and designed structural steel and concrete foundation for industrial projects. Also, involved in activities such as marketing, engineering design estimates, and answering RFP's.

JACOBS/AKER SOLUTIONS**,** Lead Civil/Structural Engineer 2010-2014

- Lead Civil/Structural Engineer for a major Copper Mill Expansion Project,
- USA, Confidential Client. Led the Civil/Structural team in the design of the structural steel and concrete foundation for the mill building, secondary screening building. Also, the Phase I and II conveying system foundations, tailings thickener's concrete foundation and containment facility, tailings launders and pipe support. The structural steel supports and foundations for all the new equipment installed inside the existing building, such as the flotation cells, cleaner cells, rougher cells, vertimills, samplers, etc. Responsible for the preparation of drawing lists, construction specifications, and standard detail drawings for the project. Responsible for tracking progress, and for the timely completion of all the civil/structural deliverables. Responsible for the coordination with the client, vendors, construction, and engineering on a fast track project. Responsible for the quality of all deliverables.

M3 ENGINEERING & TECHNOLOGY, Civil/Structural Engineer 1995-2010

- Goldcorp Inc., Penasquito Project, Zacatecas,Mexico: Senior Structural Engineer. Responsible for the structural design and engineering of major facilities for the Panasquito mine, the largest open pit mine in Mexico producing gold, silver, lead, and zinc. The project consisted of two 50,000 tonne/day sulphide processing lines, each line with one SAG and two ball mills, and a 30,000 tonne/day high pressure grinding roll (HPGR) circuit for a total production of 130,000 tonne/day. The design included equipment foundations for SAG mills, ball mills, HPGR, crushers, cyclones, vibrating screens, Vertimills, and Isamills.

EDUCATION

Master of Science in Civil/Structural Engineering, University of Arizona, Tucson, Arizona

Bachelor of Science in Civil Engineering Technological University of Panama, Republic of Panama

PROFESSIONAL MEMBERSHIPS

SEAoA- Structural Engineers Association of Arizona. Tucson Chapter President 2017-2018

AWARD

FULBRIGHT Scholarship to study master's degree granted by the Institute of International Education, USA 1986

LANGUAGE

Spanish/English